This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

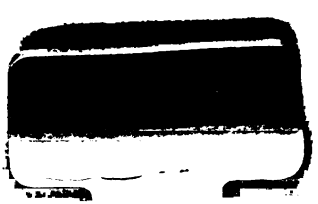
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 431273

PROPERTY OF
University of Michigan Libraries
1817
ARTES SCIENTIA VERITAS



A HISTORY

OF

THE TRADE IN TIN.

Major John Hanbury.

The Father of the English Tin-plate Trade.

UNIV. OF MICH.

A HISTORY

OF

THE TRADE IN TIN;

A SHORT DESCRIPTION OF TIN MINING AND METALLURGY;

A HISTORY OF THE ORIGIN AND PROGRESS OF THE TIN-PLATE TRADE.

AND

A DESCRIPTION OF THE ANCIENT AND MODERN PROCESSES OF MANUFACTURING TIN-PLATES.

By PHILIP WILLIAM FLOWER.

"Effodiuntur opes irritamenta malorum."

With Illustrations.

LONDON:
GEORGE BELL AND SONS, YORK STREET,
COVENT GARDEN.
1880.

[*The Right of Translation is reserved.*]

TS
590
.F64

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS,
STAMFORD STREET AND CHARING CROSS.

In Memory of my Father,

TO WHOSE EXAMPLE AND INSTRUCTION

I OWE

A TASTE FOR ENQUIRY AND A DESIRE FOR KNOWLEDGE WHICH HAVE

FURNISHED ME WITH AGREEABLE OCCUPATION

DURING THE

INTERVALS OF MY BUSINESS.

TS
590
F64

Lib.
Lowe
11-13-07
34976

INTRODUCTION.

THE earliest, or at all events one of the earliest requirements of imperfect human nature was obviously a knife, a tool, or a weapon of some sort for the purpose of self-protection, and for the assistance of the owner in obtaining and preparing such food as he consumed.

This want in the first instance was supplied by the use of stone or flint implements now called "celts," which are to be found in almost endless variety, but doubtless their shapes were adapted to the various purposes for which they were required.

Stones in their natural form were first employed, then they were roughly chipped into the shapes of wedges and scrapers, and, later, specimens are found polished and finished with judgment and care; indeed, very beautifully made stone implements are still in use among the Polynesian islanders.

The era in which these stone implements were employed dates beyond the records of man, but that there *was* a "stone age" is proved beyond a doubt by the existing collections of such implements, which have been obtained from almost every portion of the globe.

Geology demonstrates that this period of barbarism may have extended over tens of thousands of years. Civilization certainly only dates from the discovery of "fire and metals;" the first use of metals was the starting point of progress.

Greek mythology tells us that Prometheus stole the fire from heaven, but no one has been good enough to inform us who it was that first discovered the existence of tin in Cornwall.

The use of stones was naturally abandoned when the existence and value of metals was discovered; there are no records to be relied upon, but it is supposed that copper was first employed, then came bronze, which in its turn gave place to iron.

The iron age is the last of the four imagined by the poets, or rather this age is not the fruit of their imagination but a picture of human nature itself, which the poet Dryden paints as follows:

"Hard steel succeeded then,
And stubborn as the metal were the men:
Truth, Modesty and Shame, the world forsook;
Fraud, Avarice, and Force, their places took.
Then land marks limited to each his right,
For all before was common as the light;
Nor was the ground alone required to bear
Her annual income to the crooked share;
But greedy mortals rummaging her store,
Dig'd from her entrails first the precious ore,
Which next to hell the prudent gods had laid,
And that alluring ill to sight display'd;
And double death did wretched man invade;
By Steel assaulted and by Gold betrayed."

Shortly after the discovery of metals must have come the knowledge of the advantages to be obtained from their combination, for brass, an alloy of tin and copper, is frequently spoken of in the Books of Moses, and Assyrian and Egyptian bronzes exist of unrecorded antiquity.

And shortly following the use of metals must have come their adaptation to purposes of domestic use and ornament, and subsequently copper, iron, brass, and even tin-coated copper vessels were much used by the luxurious Romans for culinary purposes.

The serpent of brass which Moses caused to be lifted up in the wilderness, the pots, the shovels, the flesh-hooks and the fire-pans all made of brass, which were employed in the temple, the jewels of silver, and the jewels of gold which were borrowed from the Egyptians by the Israelites, when they went out of Egypt, are things which have been familiar

to all of us from our earliest infancy, but possibly few, if any, of us have considered or cared to inquire from whence came these metals thus early of such importance in the history of the world.

Herodotus has informed us that the gold in his time (450 B.C.) came from the north of Europe, and that it *was* said "that the Arimaspians, a one-eyed people, steal it from the griffins." Leaving it for others to clear up this matter, it will be the author's endeavour later on, to show that the tin so necessary to form brass, was produced by ancient Britons and sold to the Phœnicians, who, at a very remote period of our history, were accustomed to visit the coast of Cornwall, bartering their Eastern products in exchange for the *κασσίτερος* of our ancestors, which, when it arrived after many days at Tyre, was sold again in its turn no doubt for the manufacture of brass and bronze so largely employed for Eastern purposes.

The use of "tinned iron" followed at a much later date. Pliny certainly refers to "tin-coated" vessels, but it is uncertain whether they were of copper or iron; and although it is recorded that Alexander the Great, when in India received a present of a hundred talents of Ferrum Candidum, or "white iron," it seems to be certain that the metal referred to could not have been tin-plate as we now understand it.

Simonin says that "the history of the metals constitutes the true history of invention and labour."

So far as the writer is aware there is no existing history of tin-plates, and it will now be his endeavour to describe the origin, progress, and present position of this very important industry from such scattered information as he has been able to obtain.

CONTENTS.

CHAPTER I.

Reference to Brass in Genesis—Brass articles in Solomon's Temple—Reference to Tin and Brass in Homer's Iliad—Account of the Phœnicians and Ancient Britons—Extracts from Herodotus, Diodorus Siculus, and Strabo—History of the Trade in Tin from A.D. 409 to 1875 *Page* 1

METALLURGY OF TIN.

CHAPTER II.

Nature of Tin—Uses of Tin—Tin Ore—Tin Smelting—Adulteration of Tin—Submarine Tin Mine—Divining Rods—Future of our Tin Supply 23

HISTORY OF TIN-PLATES.

CHAPTER III.

Origin in Bohemia—Introduction into Saxony—Journey of Mr. Yarranton—Established at Pontypool—Hemming's Patent—Biography of Major Hanbury—Introduction into France—Improvements—Early Accounts of the Manufacture 37

CHAPTER IV.

Dissertation on 'The Elements of the Art of making Tin-plates,' by M. de Réaumur, translated from the "History of the Academy of Sciences," published in Paris, 1725 52

CHAPTER V.

Description of the Manufacture at Mansvaux, Alsace, established 1714, a Translation from the 'Encyclopédie ou Dictionnaire Raisonné des Sciences des Arts et des Métiers par une Société de Gens de Lettres,' published by M. Diderot, Paris, 1756 . . . . . *Page* 63

CHAPTER VI.

Early Manufacture in Germany and Sweden; translated from 'Researches and Observations concerning Mines and Iron Works, and as to the Manufacture of Steel and Tin-plates' made during travels in Germany, Sweden, &c., between the years 1757 and 1769 by M. Jars, printed in Lyons, 1744 69

CHAPTER VII.

A Descriptive Account of the several Processes which are usually pursued in the Manufacture of the Article known in Commerce by the Name of Tin Plate, by Samuel Parkes, Esq., in a Letter to B. Naylor, Esq., February 20, 1818 79

CHAPTER VIII.

Paper on the Manufacture of Tin-plates, by Mr. Ebenezer Rogers; taken from the Reports of the South Wales Institute of Engineers, 1857 93

CHAPTER IX.

Andrew Yarranton 101

CHAPTER X.

THE IMPROVEMENT OF OUR IRON AND TINN BY CONVERTING AND MAKING IT INTO PLATES COMMONLY CALLED TINN-PLATES.

[*Extracted from 'England's Improvements by Sea and Land.' By Andrew Yarranton, Gent. Published in London*, 1677.]

"The Iron and Tinn Improvements laid open to Publick View with Means and Wayes to be us'd, for obtaining the Trade of making Tinn Plats, with the Forest of Dean Iron, and the Cornish Tinn; thereby to Imploy our Poor, and encourage our Exported Trade, made of our own Minerals, Wherein is also observed the Danger we are in, from Supernumerary Priests and Free Schools, as the case now stands; with a way proposed for Relief in that Affair, that thereby Learning may not be a Burden to the Nation and Destructive to the Scholars . 111

CHAPTER XI.

A Dialogue Betwixt a Tynn Minor of Cornwal, An Iron Mynor of the Forest of Dean in Gloucestershire, And a Traveller, A.D. 1677 *Page* 120

CHAPTER XII.

Local Notes—Monmouthshire Ironworks in 1810—Pontypool Works started, 1588—Pontypool Japan Ware—History of the Hanbury Family—Neath in 1798—Ynis y Gerwn Tin Works—Neath Abbey, A.D. 1500—Caerleon in the Time of the Romans—Caerleon Tin Works—Story of Caerleon Bridge—Carmarthenshire and Glamorganshire in 1805 140

CHAPTER XIII.

Description of Modern Manufacture—Tinned Plate or White Iron—Sizes and Substances—The Forge—Forgemen—Pig Iron—The Dandy Fire—The Refinery—The Hollow Fire—Charcoal and Coke—The Helve—The Mills—Opening—Pickling—Annealing—Tin—Palm Oil—Vitriol—Coating—Advantages of Tinplate over Copper Utensils . . 156

CHAPTER XIV.

Uses and Purposes of Tin-plates 176

APPENDIX 187

LIST OF ILLUSTRATIONS.

		PAGE
PORTRAIT OF MAJOR JOHN HANBURY . . .	*Frontispiece.*	
ST. MICHAEL'S MOUNT, CORNWALL	*To face*	8
HORSE CONVEYING TIN ACROSS GAUL	„	11
EARLY MINING IN SAXONY	„	26
BOTALLACK A SUBMARINE TIN MINE	„	32
MAP OF SAXONY	„	37
MANUFACTURE OF BAR IRON IN FRANCE, 1714 . .	„	62
Do. SHEET IRON DO. 1714 . .	„	64
Do. TIN-PLATES DO. 1714 . .	„	68
FORGE OF MELYN TIN WORKS, 1878	„	158
TINHOUSE DO. DO. 1878	„	170

HISTORY OF TIN AND TIN-PLATES.

CHAPTER I.

REFERENCE TO BRASS IN GENESIS—BRASS ARTICLES IN SOLOMON'S TEMPLE—REFERENCE TO TIN AND BRASS IN HOMER'S ILIAD—ACCOUNT OF THE PHŒNICIANS AND ANCIENT BRITONS—EXTRACTS FROM HERODOTUS, DIODORUS SICULUS, AND STRABO—HISTORY OF THE TRADE IN TIN FROM A.D. 409 TO 1875.

IN the search for information through the archives of the world as to the origin and first employment of tin, one of the most ancient and most valuable of metals, shortly after the description of the flood will be found a reference to Tubal Cain, "an instructor of every artificer in brass."

Brass is an alloy of tin and copper, and analysis of the earliest existing specimens demonstrates that it was formerly manufactured in the proportions of one part of tin to nine of copper.

The notice in Genesis above referred to, fixes the discovery and use of both these metals, according to the chronology of the Christian era, at between 4004 and 1635 B.C.

And not only were the existence and use of these metals known, but the art of converting them was soon far advanced, for we find in the Book of Kings, written 1015 B.C: "King Solomon sent and fetched Hiram out of Tyre. He was a widow's son of the tribe of Naphtali, and his father was a man of Tyre, a worker in brass: and he was filled with wisdom and understanding, and cunning to work all works in brass."

Any reader who may doubt the nature of this metal can be reassured by reference to the chapter which follows, giving in detail a most elaborate schedule of the pillars, the chapiters, the baths, the lavers, the pots, the shovels, and the basons,

some of cast and some of wrought, bright brass, which Hiram the artificer prepared for the temple of King Solomon.

The pillars for the porch were cast and subsequently engraved with representations of cherubim, lions, pomegranates, lilies, and palm-trees, it would be impossible in modern times to produce any thing more beautiful than this wrought cast brass, which is still employed by Boschetti and the best manufacturers of Roman bronzes.

Passing for the moment from Bible dates and circumstances, further ample evidence as to the early use of tin and brass is to be found in the 'Iliad' of Homer, written, as it is believed, between the years 962 and 915 B.C.

The original copy of Homer's poems is said to have been drafted in golden letters on the great gut of a dragon, 120 feet in length, and to have been destroyed by fire at Constantinople, A.D. 477.

Lord Derby's world-renowned translation of the 'Iliad' furnishes the following vivid description of Vulcan manufacturing a brass shield for Achilles, which it would puzzle our modern Birmingham to design or to counterfeit:

"And first a shield he fashioned, vast and strong,
With rich adornment; circled with a rim,
Threefold, bright gleaming, whence a silver belt
Depended; of five folds the shield was formed,
And on its surface many a rare design
Of curious art his practised skill had wrought.
Thereon were figured earth, and sky, and sea,
The ever circling sun, and full orbed moon,
And all the signs that crown the vault of Heaven,
Pleiads and Hyads, and Orion's might
And Arctos, called the Wain, who wheels on high
His circling course, and on Orion waits,
Sole star that never bathes in the ocean wave;
And two fair populous towns were sculptured there,
In one were marriage pomp and revelry,
And brides, in gay procession, through the streets
With blazing torches from their chambers borne;
While frequent rose the hymeneal song,
Youths whirled around in joyous dance, with sound
Of flute and harp; and standing at their doors
Admiring woman on the pageant gazed."

Turning back again to King Solomon's temple as a starting point, we find that brass and, consequently, tin existed in Tyre 1000 years before the Christian era, and this fact furnishes a date and a city to guide us in our search for information as to the history of this metal which was then, nearly 3000 years ago, and is still of such importance in the manufactures of the world.

Tyre was a seaport town of Syria, and said to have been built 1257 B.C.; it was unsuccessfully besieged by the Assyrians for five years, 713 B.C.; it was taken and destroyed by Nebuchadnezzar, 572 B.C.; subsequently, a new and magnificent city was built (probably for safety) on an adjoining island, but this was taken by Alexander the Great, after a seven months' siege in July, 332 B.C., by means of an earthwork so constructed as to join the island to the mainland.

Syria, according to Strabo, was bounded on the north by Cilicia, on the east by the Euphrates, on the west by the Egyptian and Syrian Seas, and on the south by Arabia Felix.

The country was divided into four provinces, Syria, Cœle-Syria, Phœnicia on the coast, Judæa in the interior.

The Phœnicians, or Phainicas, are said to have been emigrants of a Buddhist or serpent worshipping tribe, who came from a district in Afghanistan (*oph-gana, aph-gana*), *gana* signifying a tribe, and *oph, aph, saph* signifying a serpent, the emblem of Boodha or Wisdom.

The Phœnicians are so frequently referred to in all works relating to tin or to Cornwall, that here perhaps it will not be out of place to give a short description of the country from whence came the traders who first crossed the seas to barter their merchandise in exchange for the tin of the ancient Britons, a commodity eagerly sought after to meet the more advanced requirements of the Eastern world.

The Syrians and Cœle-Syrians were husbandmen, but the Phœnicians were merchants, and carried on an important trade from the ports of Tyre and Sidon. These cities

rivalled each other in magnitude, fame, and antiquity, and it was a disputed question which of the two cities could be rightly termed the capital of Phœnicia.

Sidon was situated upon a fine naturally-formed harbour on the mainland. Tyre was built on an island with two harbours, one closed and the other open, the latter was called the Egyptian Harbour.

The Tyrians excelled all other nations in the manufacture of a purple dye, extracted from a shell-fish which was to be found on their coast; it is also recorded that they "possessed in abundance all *other* requisites for dyeing."

It is well known in these days that tin dissolved in muriatic acid produces a brilliant purple dye, for which Manchester is famous, and that the dissolution of tin in nitric acid will produce the "British scarlet."

We have proved the existence of tin in the city of Tyre. Is it unreasonable to suppose that the use of tin for dyeing purposes was one of the secrets which contributed to the wealth and prosperity of the ancient Phœnicians?

The Sidonians excelled in various arts: they cultivated science and philosophy, studied astronomy, and *invented* accounts; they also discovered the art of sailing by observation of the stars at night; thus we have to thank them both for navigation and arithmetic, branches of knowledge extremely important to the merchant and the seaman.

The houses in Tyre are said to have been built higher, i.e. with more storeys, than even those in Rome; it is stated that the number of the dyeing works made the city an unpleasant one to reside in, nevertheless, the skill of the people in the art of dyeing was one great source of their prosperity and wealth.

The inhabitants of both cities paid extravagant honours to Hercules; to whom they had erected most magnificent temples.

Such were the Phœnicians, the most eminent navigators and traders of antiquity, who by their harmless trade and commerce had raised themselves to be a wealthy and a powerful nation 1200 years before Christ. They had even then

established their colonies and settlements in Africa and Spain, and, some say, in Britain. The number and magnitude of their cities and colonies give proof of their maritime power and skill.

It is impossible to fix the date at which the export trade in tin was commenced from these islands, but it is certain that it existed and was controlled by the Phœnicians when Herodotus wrote his history, 450 B.C.

Herodotus refers to the Cassiterides as the place from whence they were *then* obtaining their tin supplies, but neither he nor any other historian has left us any information as to *when* that trade commenced; no one can say that it did not exist in the days of Moses, but we can only go back so far as history will take us.

But although there can be no certainty, it may not be uninteresting to inquire as to the probability of the source from whence these men of Tyre obtained the brass, or the metals which enabled them to form the brass used in the construction of King Solomon's Temple, 1000 B.C.

The Bible dates are considered to be a little uncertain, but in an historical gap of 600 years, namely, from the birth of Moses to the time of Herodotus, exact figures are neither important nor possible.

Taking it for granted then that there *was* tin in Tyre 1000 years before Christ, it must be also granted that the metal came from *somewhere*, two sources only are possible—did it come from China or did it come from Cornwall?

It is certainly possible, but not very probable, that either the brass or the tin to form the brass may have been brought to Syria from China, whose history and civilization date back to 2500 B.C., and where the metal (if discovered) was to be obtained, as at present, from the Straits of Malacca.

But the difficulties of land carriage for thousands of miles are, to say the least, very much against the probability of such a traffic, and there is no record of any sort to show that either then or later such a trade ever *did* exist between these two distant countries.

On the contrary, as to Cornwall, the first reliable history of the world which we possess refers distinctly to a trade then existing between Tyre and Britain.

The Phœnicians are known 500 years B.C. to have been possessed of fine cities, of colonies, and of a fleet of fighting-ships, and who can say that they did *not* at a much earlier period possess merchant-vessels, and who is to decide the date when, coasting up the Mediterranean, they first passed through the pillars of Hercules and crossed the Bay of Biscay to "Baratanac," as they termed the land of tin?

Bochart and other historians indeed attribute the very origin of the name of Britain to this Phœnician word Baratanac, and it is supposed that Cornwall also was so called from the Phœnician word Cornubia, which signifies a horn, and had reference to the curved appearance of the coast from the sea.

There are records in a work styled 'Periplus,' written by Arrian, a merchant of Alexandria, A.D. 64, that British tin was then passing viâ Egypt down the Red Sea to Arabia and India.

Such a trade certainly points to a *want* of this metal in the East, and this fact, when considered with the difficulty, if not the impossibility, of the land carriage and the absence of any sort of record to show that such a trade at any time existed, completes the case in our judgment *against* China.

The writings of Herodotus, our knowledge of the sea-going habits of the Phœnicians, the facilities of water carriage, and the certainty that such a trade did exist later on, seem to establish for Cornwall alone a claim to have furnished the tin to form the brass which from the very earliest ages was so much sought after in the Eastern markets.

Having thus narrated all that we have been able to ascertain as to the *unwritten* history of this metal through the dark ages of the world, and before proceeding to grapple with the uncertainties and difficulties connected with written history, we propose to give the following short account of the destruction of Tyre, which occurred in the year 345 B.C.

The Phœnicians were TOO prosperous: unhappy is the nation

and unhappy is the individual whose power or whose wealth singles him out for the envy or the fear of his neighbour.

The pride of the city of Tyre was the occasion of its destruction. The time had arrived, and not even the power of Hercules could protect the wealthy citizens from the conquering legions of Alexander the Great.

After the battle of Issus (332 B.C.), in which the Persians under Darius were defeated with great slaughter, many governors of provinces and petty princes submitted to the conqueror, and among the places which sent deputies to the king was the city of Tyre.

The king of Tyre, whose name was Azelmicus, was absent in the Persian *fleet*, but his son was among the deputies, and was favourably received by Alexander.

The following description is taken from 'Bloomfield's Geography,' fol. 513:

"The king probably intended to confer particular honours on the city of Tyre, for he acquainted the inhabitants that he would come and sacrifice to the Tyrian Hercules, the patron of their city, to whom they had erected a most magnificent temple, but these people, like most other trading nations, were too suspicious to think of admitting such an enterprising prince with his troops within their walls. They sent, therefore, their deputies again to him to inform him that they were ready to do whatever he should command them, but as to his coming and sacrificing in their city they could not consent to that, but were positively determined not to admit a single Macedonian within their gates. Alexander immediately dismissed their deputies in great displeasure and assembled a council of war, wherein he insisted strongly on the disaffected state of Greece (for most of the Grecian States had sent ambassadors to Darius to enter into a league with him against the Macedonians), the power of the Persians by sea, and the folly of carrying on the war in distant provinces while Tyre was left unreduced behind them. He also remarked that, if once this city was subdued, the sovereignty of the sea would be transferred to them, because

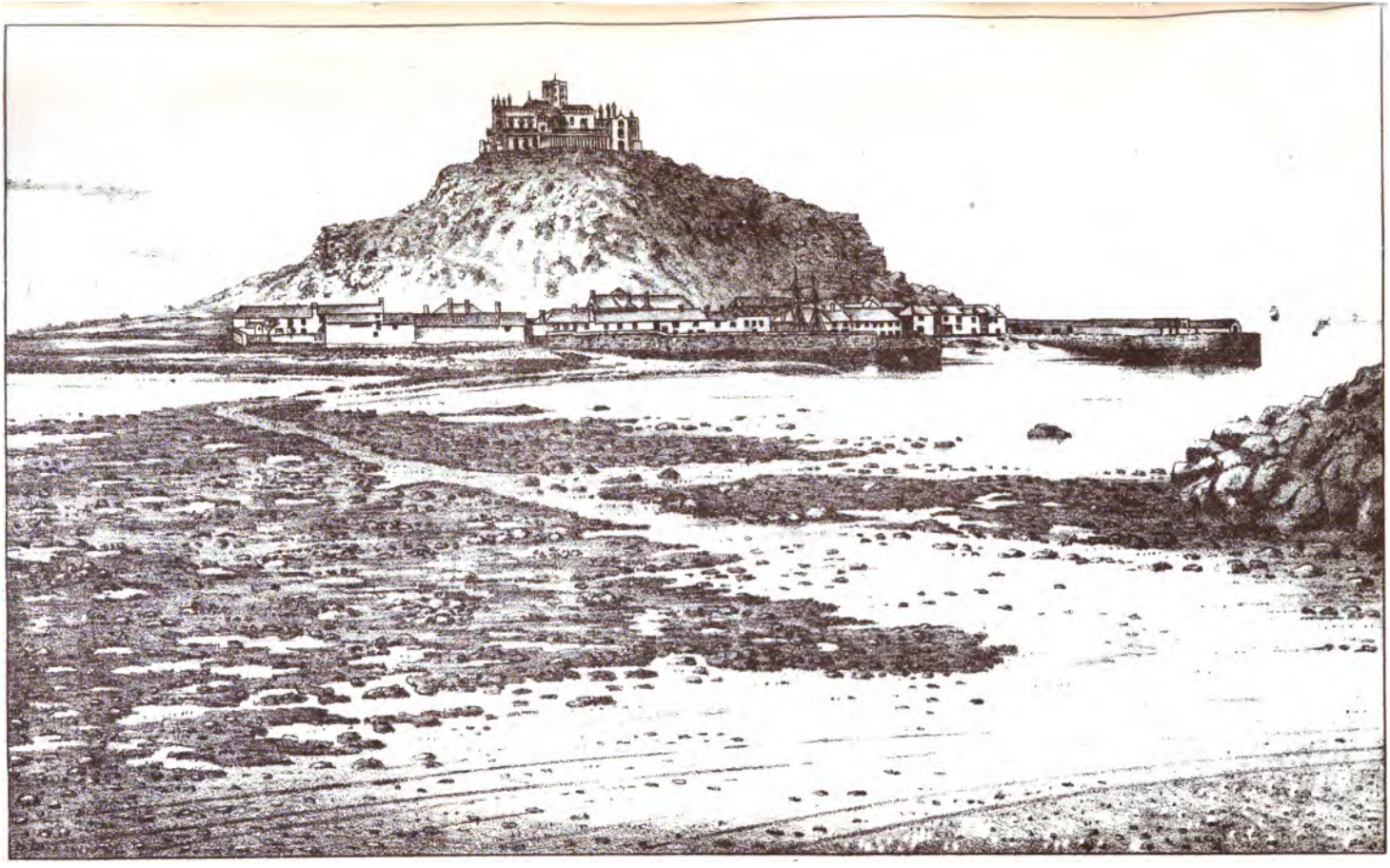
it would fix their possession of the coasts, and as the Persian fleet was composed chiefly of tributary squadrons, those tributaries would fight the battles not of their late but of their present masters."

For these reasons the siege of Tyre was resolved upon, but the town was not taken without much difficulty, which provoked Alexander to such a degree that he treated the inhabitants with the greatest cruelty.

Thus perished the power of the Phœnicians, the most commercial people of all antiquity.

They affected no empire but that of the sea, and seemed to aim at nothing but the peaceable enjoyment of their trade. This they extended to all the known parts they could reach, to the British isles, commonly understood by the Cassiterides, to Spain, and other places in the ocean, both within and without the Straits of Gibraltar, and in general to all the ports of the Mediterranean, the Black Sea and the Lake Mæotis.

In all these parts they had settlements and correspondents from whom they drew what was useful to themselves or might be so to others; and thus they exercised the three great branches of trade as it is commonly divided—importation, exportation, and transportation in full latitude. Such was their sea trade, and for that which they carried on by land in Syria, Mesopotamia, Assyria, Babylonia, Persia, Arabia, and even in India, it was of no less extent, and may give us an idea of what this people once was, how rich and how deservedly their merchants are mentioned in Scripture as equal to princes. Their country was at that time the great warehouse where all things which might either administer to the necessities or luxury of mankind were to be found; these they distributed as they judged would be best for their own interests. The purple of Tyre, the glass of Sidon, and the exceeding fine linen made in this country, together with other curious pieces of art in metals and wood already mentioned, appear to have been the chief, and almost only commodities of Phœnice itself. Indeed, their territory was so small, that it is not to be imagined they could afford to



ST. MICHAEL'S MOUNT, CORNWALL.

export any of their own growth; it is more likely that they rather wanted than abounded with the fruits of the earth.

Historians differ as to whether the Phœnicians did or did not recover from the destruction of Tyre. Strabo considers that they rose above these misfortunes, and recovered themselves by their manufactures and the skill of the people in the art of navigation.

Having now passed into the period of written history, we can approach the subject with a little more confidence as to dates and circumstances.

Herodotus, writing 450 B.C., confesses (very properly) to an imperfect knowledge of the subject, but gives us the following information relating to tin and to gold:—

"Concerning the western extremities of Europe, I am unable to speak with certainty, for I do not admit that there is a river called by barbarians, Eridanus, which discharges itself into the sea towards the north, from which amber is said to come; nor am I acquainted with the *Cassiterides Islands* from whence *our tin comes*. For, in the first place, the name Eridanus shows that it is Grecian and not barbarian, and feigned by some poet: in the next place, though I have diligently inquired, I have never been able to hear from any man who has himself seen it, that there is a sea on that side of Europe. However, both *tin* and amber come to us from the remotest parts.

"Towards the north of Europe there is evidently a very great quantity of gold, but how procured I am unable to say with certainty, though it is said that the Arimaspians, a one-eyed people, steal it from the griffins.

"Neither do I believe this, that men are born with one eye, and yet in other respects resemble the rest of mankind. However, the extremities of the world seem to surround and inclose the rest of the earth, and to possess those productions which we account most excellent and rare."

After the Phœnicians the trade in tin with the Cassiterides was taken up by the Greeks sailing out of Marseilles, the

city of Massilia which was built by a colony of Phocian Greeks, 600 B.C.

The Phœnicians probably sailed straight across from their colony of Gades or Cadiz, and returned direct to that port with their valuable cargoes.

They would be enabled to do this by their superior navigation and their power of sailing by the stars; it would be impossible for vessels which anchored at night to cross the Bay of Biscay from Gibraltar to Cornwall.

The Greeks, on the other hand, were accustomed to coast up the English Channel, and crossing over from Kent to France the tin was conveyed overland on horseback in thirty days to the mouth of the river Rhone.

Diodorus Siculus gives the following very distinct account of this trade as carried on by the Greeks from Britain to Gaul.

"The inhabitants of that extremity of Britain which is called Bolerion (supposed to be Land's End) excel in hospitality, and by reason of their intercourse with foreign merchants they are civilized in their mode of life.

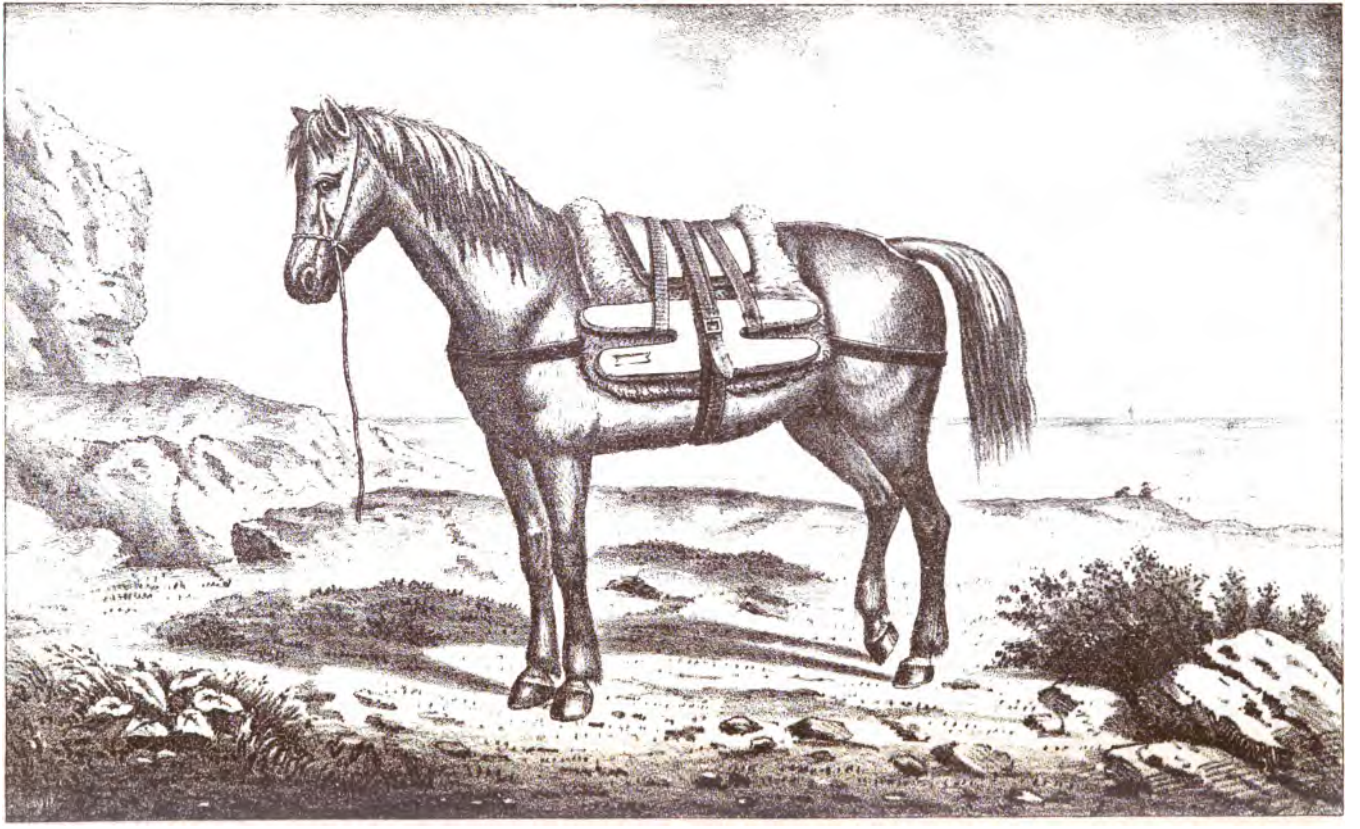
"These people prepare the tin, working very skilfully the earth which produces it.

"The ground is rocky, but it has in it earthy veins, the produce of which is brought down and melted and purified.

"Then, when they have cast it into the form 'of knuckle-bones,' they carry it to a certain island adjoining to Britain and called Ictis. (St. Michael's Mount.)

"During the recess of the tide the intervening space is left dry, and they carry over abundance of tin to this place in their carts, and it is something peculiar that happens to the islands in these parts lying between Europe and Britain, for at full tide the intervening passage being overflowed they appear islands, but when the sea returns a large space is left dry, and they are seen as peninsulas.

"From hence, then, the traders purchase the tin of the natives and transport it into Gaul, and finally, travelling through Gaul on foot in thirty days, they bring their burdens on horseback to the mouth of the river Rhone."



In a paper published by Major-General Sir Henry James, F.R.S., in the 'Archæological Journal,' No. III. 1871, a description is given of a block of tin dredged up at Falmouth about 1811, which from its shape explains very clearly the cleverness of these "old men," in dealing with such weights as even at the present day are troublesome.

The author has taken the liberty of reproducing the clever drawing, from which it will be apparent at a glance how easy it was for men to handle and for horses to carry blocks of tin shaped in the manner which Sir Henry has described.

The same paper, moreover, clears up the uncertainty, or rather settles the controversy as to the situation of the island Ictis referred to by Diodorus and other historians as the station where the tin was stored, and the barter carried on between the ancient Britons and the dealers who traded with them.

Sir Henry James further explains very clearly that it would take a six days' passage up the coast from St. Michael's Mount to Hythe or Deal, and a thirty days' journey at the rate of twenty miles a day from Calais or Boulogne to Marseilles; these are the exact figures given by Diodorus, and besides this no other port *can* be mentioned to correspond with such facts as Diodorus has stated for us.

The Romans, who had always been large purchasers of tin, were the next to follow the Phœnicians and Greeks, and the following amusing account of their endeavours to "deal direct" is taken from Strabo, who also describes how, under Cæsar, they finally "came, saw, conquered," and took possession of this island and the mines for themselves:—

"The Cassiterides are ten in number, and lie near each other in the ocean towards the north from the haven of the Artabi. One of them is desert, but the others are inhabited by men in black cloaks, clad in tunics reaching to the feet, girt about the breast, and walking with staves, thus resembling the tunics we see in tragic representations. They subsist by their cattle, leading for the most part a

wandering life. Of the metals they have *tin* and lead, which, with skins they barter with the merchants for earthenware, salt, and brazen vessels. Formerly, the Phœnicians alone carried on this traffic from Gades, concealing the passage from every one, and when the Romans followed a certain shipmaster, that they also might find the market, the shipmaster of jealousy purposely ran his vessel upon a shoal, leading on those who followed him into the same destructive disaster, he himself escaped by means of a fragment of the ship, and received from the state the value of the cargo he had lost. The Romans nevertheless, by frequent efforts, discovered the passage, and as soon as Publius Crassus, passing over to them, perceived that the metals were dug out at a little depth, and that the men were peaceably disposed, he declared it to those who already wished to traffic in this sea for profit, although the passage was longer than that to Britain."

Publius Crassus, father of Marcus Crassus, the triumvir, who was prætor, and governed Spain for several years, landed in the Cassiterides, and found the report of their riches verified.

As soon as the Romans made a conquest of the country, they formed in the tin province camps and roads (still visible), and left behind them vases, urns, sepulchres and money that exhibit daily proofs of their having been a stationary people in those parts, and that Damnonium extended even to the Bolerian promontory or the Land's End, and was not, as some writers imagine, limited by the western parts of Somersetshire.

It is not to be imagined that they could neglect a corner of our island productive of a metal so useful in manufactures as tin, which is yielded in such abundance as to receive from that circumstance the name.

It would be ungenerous and ungrateful, and this volume would be incomplete, were we to pass on to modern times without some reference to the manners and customs of our ancestors, the ancient Britons, who, in their rough way, from

2500 to 3000 years ago, were extracting from their native soil the tin which was to adorn the temples of the Eastern world, and to form the armour of the heroes engaged in the fearful struggles which are described by Homer; possibly the helmet of Agamemnon and the shield of Achilles were manufactured from the brass which was made from the Cornish tin imported by the Phœnicians and sold for that purpose.

"The Britons at this time, according to Cæsar and other Roman historians, were very numerous, and had their country well stocked with cattle; their houses resembled those of the Gauls, and they used copper or iron plates weighed by a certain standard, instead of money; their towns were a confused parcel of huts placed at a small distance from one another, generally in the middle of a wood, to which all the avenues were slightly guarded by ramparts of earth or with trees. All the nations were in a state of the most wretched barbarism, even when compared with the barbarous Gauls on the continent.

"The use of clothes was scarcely known in the islands; only the inhabitants of the southern coast covered their nakedness with the skins of beasts, and this rather to avoid giving offence to the strangers who came to trade with them than out of any principle of decency. It was a general custom among the Britons to paint their bodies with the juice of woad, but whether this was designed as ornament or for any other purpose is not known; they shaved their beards, all except their upper lip, and wore long hair; they also had their wives in common, a custom which made them detestable to all other nations.

"The arms of the Britons were a sword, a short lance, and a shield; breast-plates and helmets they looked upon rather as encumbrances, and therefore made no use of them; they usually fought in chariots, some of which are armed with scythes at the wheels; they were fierce and cruel, and exceedingly bloodthirsty. When driven to distress, they could subsist themselves even on the bark and roots of trees; and

Dio Cassius tells us that they had ready, on all occasions, a certain kind of food of which if they took but the quantity of a bean, they were not troubled with hunger or thirst for a considerable time after. The southern nations, however, were somewhat more civilized, and the Cantii or inhabitants of Kent more so than any of the rest.

"Notwithstanding all the barbarism of the ancient Britons, it is pretty certain they were acquainted with commerce for several centuries before the Christian era. The Phœnicians visited the coast of Cornwall for tin, with which that county has ever abounded; they must therefore have either formed settlements for the purpose of working mines, or the natives could not have been ignorant of the nature of metals. From the Phœnicians or Greeks, who succeeded them in this trade the Scilly Islands received the appellation of Cassiterides, or islands of tin. Strabo says they were ten in number, lying close together, of which only one was inhabited; the people led a wandering life, lived upon the produce of the cattle, wore an under garment which reached down to their ankles, and over that another, both of the same colour, which was black, girt round a little below the breast with a girdle, and walked with staves in their hands.

"The riches of these islands were *tin* and lead, which, as well as the skins of their cattle, they exchanged with foreign merchants, that is the Phœnicians from Cadiz, for earthenware, salt, and utensils made of *brass*."

"These islands are represented to have been in circumstances very different from their present, since an author of great antiquity seems to include a part at least of Cornwall amongst these islands, or rather he suggests that they were not perfect islands except at full sea, but that at ebb the inhabitants passed from one to another upon the sands, and that they even transported their tin in large square blocks upon carriages from one island to another.

"He further takes notice that such as inhabited about Belerium (the Land's End) were in their conversation with strangers remarkably civil and courteous. Other ancient

writers style these islands Hesperides, from their western situation and Œstrymnides, asserting that the land was extremely fertile as well as full of mines, and that the people, though very brave, were entirely addicted to commerce, and boldly passed the seas in their leather boats.

"It appears probable that the Britons, like the Gauls, consisted chiefly of three different ranks, the common people, the gentry, and the Druids.

"The common people were accounted as servants, dared to undertake nothing of their own authority, and were present at no councils. Many of them, when they were oppressed either with debts, or the weight of taxes, or the injuries of the powerful, sold themselves into servitude to the nobles, who possessed over them the same dominion as masters had over their servants."

The gentry or nobility were constantly trained to war, and such of them as were the most distinguished for birth and riches had the greatest number of followers and dependants. Another author informs us that—

"The Britons exported, principally from the estuary of Sabrina, tin, a little gold and silver, lead, iron, hides, cattle, some species of corn, perhaps oats, some brilliant stones they denominate gems, mussel-pearls, horse-bits formed of bone, horse-collars, amber toys, and glass vessels. They imported earthenware, salt, instruments, weapons, and trinkets of brass, and small quantities of iron. The Romans created, or improved, parts of that commerce by stimulating, sometimes forcing the industry of the Britons, and by improving all the branches of their art of navigation."

In those circumstances, their means of exchange or money are objects of curiosity. According to Strabo, the commerce of the Phœnicians with the southern extremities of Britain was by an exchange in kind, and even in the reign of Tiberius, the British trade is said to have been conducted without the aid of money. Cæsar says the Britons possessed no money, but used pieces of brass and iron unstamped, and

which they estimated by weight. Strabo, however, affirms that Cæsar, in his expeditions, found considerable treasure of booty. The first coins are those of Cunobeline, the successor of Cassivelaun, King of the Trinobantes, and the device proves the art was Roman, for it is generally a centaur, a Pegasus, a Sphinx, or a Janus. The inscriptions are imitations of the Roman alphabet, and sometimes in the Latin language. As the Romans extended their dominion in the island, they usurped the right of coining.

Cæsar and Pliny describe the ships of Britain as clumsy frames of rough timber, ribbed with hurdles and lined with hides, of which models in miniature may be seen in the coracles still in use on the rivers of Carmarthen and Cardigan. The sea-boats had masts and sails, according to Claudian, but were generally rowed, the rowers singing, accompanied by the harp. The signal of the commander was given by striking on a shield hanging on the mast. They steered by the stars.

The Romans, as is well known, occupied Britain from B.C. 55 to A.D. 409, during which period the Cornish tin mines were largely worked by the ancient Britons, possibly for their own advantage, but more probably as serfs, and in A.D. 409 the Romans had to give way to the Saxons.

During the Saxon dominion (from 410 to 1066) the mines were almost entirely neglected, frequent intestine commotions and the subsequent wars with the Danes allowing no time for such innocent and peaceful pursuits.

The only records of this Saxon dynasty were a few manuscripts written on skins and preserved by the monks.

In the year of the conquest 1066, the Saxons in their turn were pushed aside by the Normans, and subsequently the tin mines in Cornwall were again vigorously developed.

The Norman sovereigns derived immense revenues from the export of this metal, and in the year 1198, when the country was almost ruined by the Crusades, Richard Cœur de Lion, then abroad, placed the management of the mines in the hands of the Archbishop of Canterbury, who, from this and other sources, was enabled to collect and remit

to his employer a sum of money exceeding 1,000,000*l.* sterling.

In the reign of King John, 1199–1216, the produce was so inconsiderable, that the rent of the tin farm amounted to no more than 100 marks.

At this period the Jews were sole managers if not proprietors of the mines, and memorials of them are still to be found in the names of different places in the county of Cornwall.

The right of working the mines was then wholly possessed by the King, who, being sensible of the languishing state of the manufacture, bestowed some valuable privileges on the county by relieving it from the operation of the arbitrary forest laws, and granting a charter to the tinners.

It is not very easy to understand how, in the absence of foreign competition, this depression of the trade came about, for up to the year 1240 Cornwall possessed a monopoly of the supply for Europe.

Tin mines were known to exist in Spain, but the constant invasions of the Moors caused the mines to be abandoned or neglected.

In the year 1240, however, tin was discovered in the mountains of Bohemia by a Cornish tinman banished from England, either on account of his religion or because he had committed murder. Further discoveries followed at Altenburg in Saxony, 1458, and in Barbary, 1640.

Richard Duke of Cornwall, brother to Henry III., 1216–1272, derived immense profits from the mines, the produce of which was subject at this period to a royalty of forty shillings for every 1000*l.* in value payable to the duke, and twice every year all tin produced had to be brought to appointed places, where it was officially stamped and weighed.

Truro possessed a coinage hall as early as the reign of King John, where the blocks of tin were to be seen in heaps about the streets, and were left entirely unguarded, as their great weight rendered it difficult to remove them without immediate detection.

After the cost of obtaining the tin and after the coinage and other legal duties were paid, it might be supposed that the producer was free to sell his tin to the best advantage, but this was not the case, for the king and duke reserved the right of pre-emption should they "feel like" taking a "flyer" in tin.

The Jews being banished the kingdom in the eighteenth year of Edward I., 1290, the mines were again neglected, till the gentlemen of Blackmoor (lords of the seven tithings best stored with tin) obtained a charter from Edward Earl of Cornwall, son of Richard, King of the Romans, with more explicit grants of the privileges of keeping a court of judicature, holding pleas of actions, managing and deciding all stannary causes, of holding parliaments at their discretion, and of receiving as their own due and property, the toll tin, that is, the one-fifteenth of all tin raised.

Our kings and dukes in these times would appear to have treated this industry very lightly, for it is recorded that Edward I., in 1305, in the thirty-second year of his reign and the thirty-sixth of his age, mortgaged or assigned his due for one year, to settle a wine bill of 750*l.*

Edward II., 1307–1327, granted the stannaries to a favourite named Gavestan, and subsequently the same king made them over as a present to his butler and valet.

In 1337, Cornwall was made a duchy by Edward III., and a grant of the stannaries was made to his eldest son, Edward the Black Prince, but, in 1338, for some unexplained reason the king seized all the tin mines and the tinners ceased to work.

In 1376 the tinners were able to obtain protection by Act of Parliament, but the civil wars following, namely, the Wars of the Roses (which commenced by the claim of the Duke of Gloucester to the throne in 1449, and ended by the defeat and death of Richard III. in the Battle of Bosworth Field), the mines were again very much neglected.

When, in 1485, the union of the Roses was effected by the marriage of Henry VII. with Elizabeth, daughter of Edward

IV., England became more settled, and tin mining again became profitable and prosperous.

Haydn states that, in these dreadful wars, there perished twelve princes of the blood, 200 nobles, and 100,000 gentry and common people.

In the time of Henry VIII., 1492–1509, an Act of Parliament was passed enacting, "That no person shall buy tin or any wares made of tin out of the realm; officers may seize such wares if imported," &c.

This decree was probably the result of threatened competition from Germany, arising from the discovery of 1240 in Bohemia, before referred to.

Some writers express doubt as to whether this discovery *was* made by a Cornish man, but Yarranton relates that a statue was erected to his memory, and existed in 1670 at the town of Awe, in Bohemia.

Our prudent Queen Elizabeth, 1558–1603, appears to have taken more interest in the mines than her predecessors, for she sent to Germany and brought over German miners, by whom many of the Cornish processes were very much improved.

Very little has been written, next to nothing can be ascertained, of the progress of this trade from 1600 to 1700; nevertheless, laws and statutes were passed and exist regulating the coinage, fixing penalties for adulteration, and restricting the right of "free search," facts which show that in spite of the troubles of the rebellion the trade was being actively followed up.

In the reign of Anne, 1702–1714, it is recorded that the queen had in stock 5000 tons of tin, equal to five years' consumption, demonstrating the existence of "hard times" for the producers, or proving that the queen was a "hard bargain" to deal with.

It was after the death of Queen Anne, but there appears to be no record of the exact date when Eastern or foreign tin first arrived in Europe to compete with Cornish produce, but as early as 1760 small quantities of Banca tin were received in Holland; and the following figures would

seem to show that the mines had only been recently opened, or at all events had not arrived at any degree of importance:—

IMPORT OF BANCA TO HOLLAND.

	Tons.		Tons.
1760 .	324	1765 . .	279
1761 . .	185	1766 . .	146
1762 . .	325	1767 . .	167
1763 . .	369	1768 . .	311
1764 . .	60	1769 . .	457

In the year 1787 the importation of Banca to Holland amounted to 543 tons, and this quantity being too much for their own requirements the Dutch began to seek a market in England, but unfortunately in the same year the Cornish supplies increased upwards of 500 tons.

These combined circumstances produced a panic, prices rapidly fell from 72*l.* to 58*l.*, and the importation of Banca fell off from

Year.	Tons.
1787	543
1788	80
1789	40

The market was then relieved by the purchases of the East India Company, who were accustomed to buy 800 tons annually for shipment to China, the trade originating under the following circumstances.

Mr. George Unwin, the purser of an East India ship, in 1787, as an adventure took some tin from the Malacca Islands to China, and made a handsome profit by his speculation. On his return to England, having learned the price of tin in Cornwall, he brought the subject before the East India Company, and showed that the price of Cornish tin being so low, it might be sent to China as cheaply as the Dutch could send their Malacca tin thither.

In 1789 the East India Company purchased and sent out a small quantity, which fully answered their expectations, upon which they entered into arrangements with the tinners

of Cornwall for an annual supply. This exportation to India speedily advanced the price in Cornwall, but the Cornish men, having found the benefit of such a connection, were not easily induced to relinquish it. An artificial system was therefore created, by which the East India Company were still supplied at a lower price than that paid to the tinners in Cornwall, whilst the price in the home market was kept high enough to make up the deficiency. By this system the quantity delivered to the East India Company had always reference to the produce of the mines, and the demand at home varying from 500 to 1500 tons per annum, the average price of tin in Europe was much higher than it otherwise would have been.

This very interesting trade with China was brought to a close in 1817 by *the return* of Cornish tin from China to London, and the consequent underselling of the artificially-priced Cornish produce.

Such a state of things could never exist in these days, and it is a wonder that it could even then have been maintained.

If in these days tin for export could be obtained at 25*l.* per ton below the price of tin for consumption, it would be sold by telegraph for re-arrival from the port to which it was exported, and the seller would find himself undersold the next day by his purchaser.

The history of tin from that date to the present is only a question of figures and statistics, which will more properly find their place in the Appendix for the information of those who are sufficiently interested to study them.

The requirements for export and for home consumption have year by year increased, and with them the supplies from Cornwall and the East have been constantly increasing.

The Cornish supply, which was 2500 in the year 1800 exceeded 10,000 tons in 1873, and this quantity was more than doubled by importation, from the East.

The price has ranged from 60*l.* to 150*l.* per ton, influenced by the abundance or scarcity of the metal itself; high prices, which stimulate supply and restrict consumption, invariably

result, in excessive production, and accumulation of stocks followed in their turn by lower prices and by restriction of out-put.

Increased consumption results from low prices, and values again advance, prices which favour consumers are bad for producers, and consumers suffer when producers are prosperous; but each one has to go from good times to bad, and from bad times to good, *nolens volens*, from pillar to post, as he journies through the world.

METALLURGY OF TIN.

CHAPTER II.

NATURE OF TIN—USES OF TIN—TIN ORE—TIN SMELTING—ADULTERATION OF TIN—SUBMARINE TIN MINE—DIVINING RODS—FUTURE OF OUR TIN SUPPLY.

TIN; *Stannum, Plumbum Album, Jupiter; German, Blech; French, Étain; Italian, Latta; Spanish, Hoja de Lata; Russian, Blärha; Arabic, Resas; Sanscrit, Trapu; Malay, Tima; Hindostan, Kalai; Siamese, Dibuk; Burmese, Kye-p'ku.*

THIS metal which, after gold and silver, ranks first in value, is at the same time the lightest and most fusible of metals; tin is only seven times heavier than water, but, although the metal is so light, the ores are of the heaviest.

Tin ore is peculiar to the primitive rocks, and is generally found in granite; the metal produces a curious crackling sound when bent, has a slightly disagreeable taste, and has a peculiar smell when rubbed.

Tin melts with a gentle heat, and is very ductile under the hammer, yet it cannot be drawn into wire.

Tin considered upon its own merits is next to valueless as a metal, but used as an alloy or employed as a coating for other metals, it is possibly the most valuable which we possess.

Tin is sometimes given as a Medicine, and is employed for the preparation of cosmetics; it is used in the varnishing of earthenware, and, dissolved in nitric, muriatic, or sulphuric acid, it will produce purple, scarlet, or yellow dyes. There

are, however comparatively very few uses for which *pure* tin can be employed.

Mixed with copper in the shape of brass or bronze, its uses and purposes are almost endless and invaluable; from the bells of our cathedrals, or the highly finished breech-loading far ranging bronze guns of modern artillery down to the humble brass-button—the emblem of worthlessness—or a pair of brass hinges, we meet with tin everywhere and in every-day use.

Employed as a coating for brass or copper cooking utensils, it serves the purpose of protecting from the poison of verdigris, the food which is being prepared for the wealthy or prejudiced households who would scorn the use of anything so mean as a saucepan *made* of tin.

Used as a coating for iron in the manufacture of tin-plates, tin finds its largest and most expanding market; iron without tin would be valueless for most of the purposes to which coated iron can be applied; tin of itself would bruise, would bend, would melt, and moreover would prove far too valuable for the thousand and one purposes for which tin-plates are employed.

It is, then, the skilful combination of tin with iron which has created the immense and ever increasing consumption of English and foreign tin, and in tin-plates we find the lightest, strongest, brightest, cleanest material that we have, which is beyond competition, and which above all produces the *cheapest package* which can be obtained.

Tin was employed at a very early period for the purpose of coating iron and copper, but of the process employed we have no account; the words of Pliny, A.D. 23, *incoquere* and *incoctilia*, seem to imply that it was performed as in tinning iron wares, i.e., by immersing the vessels in melted tin.

It would also appear that it was done very cleverly, for Pliny relates that the tin coated vessels were scarcely to be distinguished from silver, and he expresses surprise that the coating did not materially increase the weight of the vessels. The same historian observed that the coating of tin improved the taste of the food; and he mentions, as a curious experi-

ment made with tin, that when melted and poured upon paper it seemed to break the paper by its *weight* rather than by its *heat*. Aristotle, writing long before Pliny, had remarked the small degree of heat which was requisite to fuse Celtic or British tin.

It is uncertain what metal is meant by the Plumbum Album and Plumbum Candidum of Pliny, and nobody seems to know whether the *vasa stannea* of the Latin authors were vessels produced by casting from tin itself or brass and copper vessels coated over with tin.

The Romans no doubt made use of tin (purchased from the Phœnicians) to form their brass helmets and shields, and, in the reign of Nero, it is said that base tin coin was circulating in counterfeit of silver; it is nevertheless remarkable that vessels of pure tin or vessels coated with tin have been very rarely found amongst Greek or Roman antiquities.

As in the history of the trade in tin, so in the history of its metallurgy; little, very little, information exists to guide us in our search as to the origin, nature, and progress of this important industry.

There are, in different parts of Cornwall, many extensive chasms which bear evidence of the very early commencement of mining, pickaxes of horn and box-wood, and shovels made of oak have been found showing the rudeness of the tools with which the "old men" worked.

Grinding-mills, somewhat similar to those in use for grain, and ingot moulds, both hewn out of the solid granite, have been discovered, and remain to show the method by which the metal was obtained, but we have no written records as to dates and quantities.

In the museum of the Cornwall Geological Society at Penzance, may be seen a shovel and a pickaxe found near Truro—the shovel formed of the knotty part of heart of oak, the pickaxe made out of the antlers of a stag.

The shovel has the appearance of having been much used, and is fitted to the handle by a thong of hide which is tanned and in perfect preservation.

These implements may very well suggest the thoughts,

what rate of wages was then in vogue and how many hours went to the day, and whether these tools were accidentally overlooked or purposely "left in" when the owners were "locked out," resisting the decree of some too exacting task-master.

The expense of raising was moderate, no doubt, for the whole cost was labour, and, judging from the nature of the work, the number of people employed must have been very small in comparison with the number now required to produce the same quantities of ore, and as their want of knowledge and appliances prevented them from following the ore below the water, they altogether avoided the cost, now so excessive, of coal, timber, and machinery.

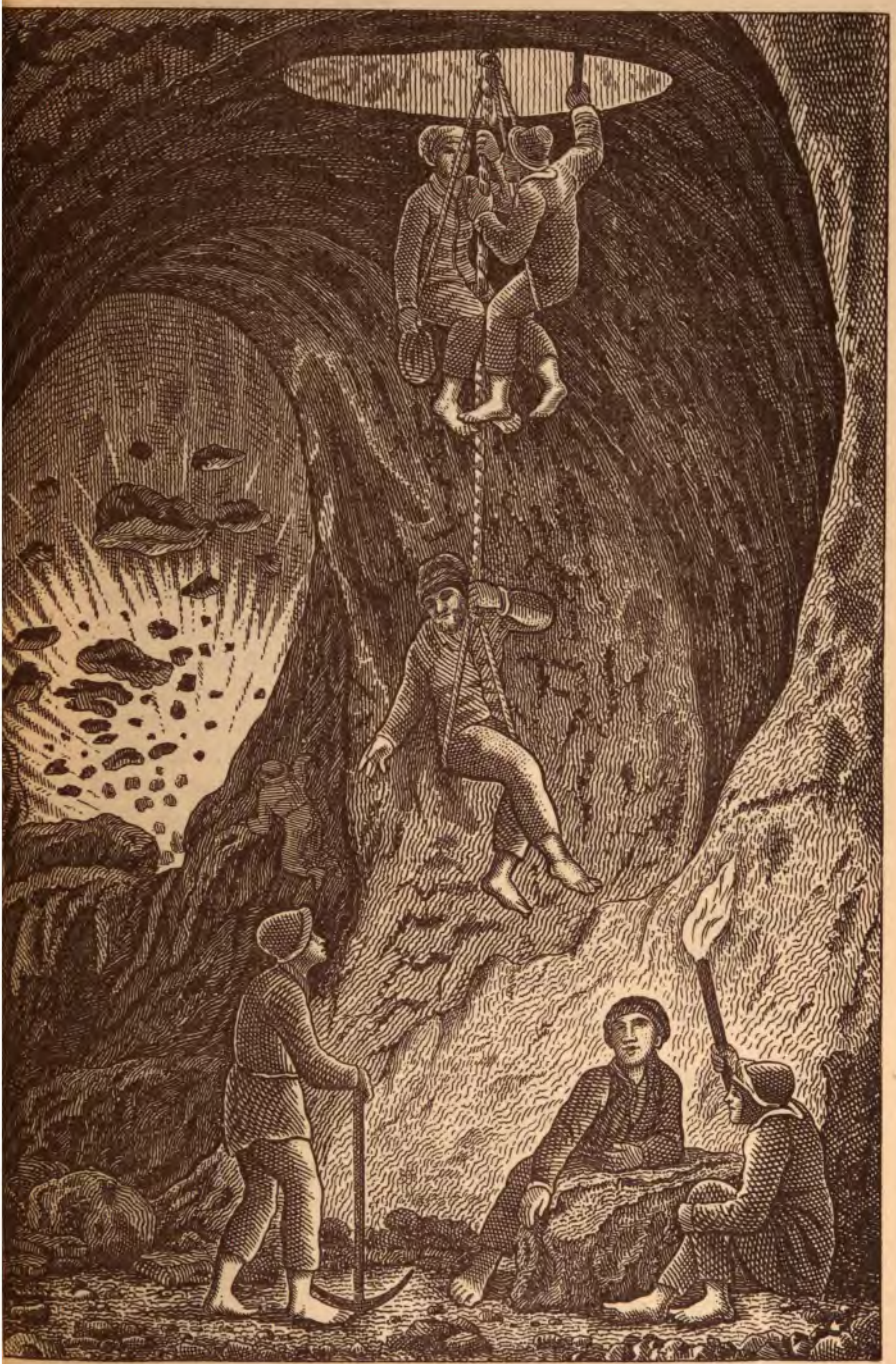
The ore, no doubt, in the first instance, was obtained from surface workings or stream work in the same way as gold and tin are even now collected in Australia; a pickaxe, a shovel, and a knowledge of how to use them would be quite sufficient for this purpose.

The use of water for mining purposes is at the same time the earliest, the cheapest, and the most effectual process. A vein or bed of ore being discovered a current of water is made to pass over it, by which the earthy impurities are removed, and the ore, *clean* and heavy, is left behind to be subsequently dealt with. If the water is convenient the cost is trifling, but if the water is distant it must be brought to the spot before the tin-mine can be developed.

In process of time, as a matter of course, surface deposits were liable to become exhausted, and even long before this happened the cost of metal must have been increasing from the use of inferior ores, and the longer distances for conveyance from the stream works to the smelting-houses.

In a desire for the reduction of cost may be found the motive for most human improvements; in this instance, it resulted in a determination to follow the ore below the level of the water by means of pits and shafts, and from that day to the present, Cornish men have been sinking deeper and deeper in their search for cheaper metal.

In the first instance, whatever earth or ore was excavated,



EARLY MINING OPERATIONS IN THE MOUNTAINS OF SAXONY.

and whatever water had to be raised, was passed from hand to hand on to a succession of platforms or stages; then the windlass was introduced from Germany, used with buckets for raising both water and earth; then followed pumps first worked by men, then by horses, then by water-wheels, and finally by the steam-engine from its rudest to its comparatively perfect construction. In Cornwall may be found to-day some of the largest and best constructed engines in the world. Cornish boilers, engines, and machinery have at all times set the example and led the way for mining industry both at home and abroad, and the more such machinery is perfected, the deeper the miners can descend into the bowels of the earth.

Until the latter part of the seventeenth century, all the tin produced in Cornwall whether from streams or mines was smelted in blast furnaces with charcoal. It was not until the former part of that century that pit coal had been successfully applied to the smelting of any of the metals; the decrease of wood in Cornwall, and the consequent increase of expense in smelting tin with charcoal, naturally induced the tinners to turn to any substitute, and to try the use of pit coal. This was probably the immediate cause of the introduction of air (reverberatory) furnaces in which the fuel and the ore were separated, and culm coal (possessing many of the properties of charcoal) mixed as a flux with the ore.

The first air furnace for smelting tin was erected about the year 1680, since that period nearly all the mine tin of Cornwall has been smelted in air furnaces.

There are three kinds of tin made in Cornwall, viz., grain tin, refined tin, and common tin.

Grain tin was formerly made solely in blast furnaces, and only from diluvial tin ores, or what is generally called stream tin, remarkable for its superior purity.

It was formerly the only kind of tin, used for making tin-plates, on account of its fluidity and of its superior colour and lustre.

In 1800 when scarcely enough grain tin could be procured

for the use of the tin-plate manufactures, the smelters, by selecting particular ores, commenced making tin of a quality fluid enough for tin-plates, although not of the best colour; this was used for the first coat on the iron plate and grain tin for the second (for all plates are dipped twice in tin). This is called refined tin, and its quality has been so much improved (although it is still unequal to grain tin) that by most manufacturers no other tin is now used.

Tin Ore.

The following Account of Tin Ore is taken from 'Beauties of England and Wales.'

"Now those profounder regions we explore,
Where metals ripen in vast cakes of ore,
Here sudden to the sight, at last is spread
The dull, unwieldy mass of lumpish lead;
There, glimmering in the dawning beds, are seen
The more aspiring seeds of sprightly tin;
The copper sparkles next in ruddy streaks,
And in the gloom betrays its glowing cheeks."

The most valuable metal produced in Cornwall is tin, which is sometimes found collected and fixed, and at others loose and dilated.

In the former state it is either in a lode or floor, which is an horizontal layer of the ore: or interspersed in grains and small masses in the natural rock. The floors are frequently deep and very rich, but the expense of working them is generally considerable, from the quantities of large timber necessary to support the several passages of the mine.

The same lode that has continued perpendicular for several fathoms, is sometimes found to extend suddenly into a floor. Tin, in its dispersed form, is either met with in a pulverized sandy state in separate stones called *Shodes*, or in a continued course of stones which are sometimes found together in such numbers that they reach a considerable length, and are found from one to ten feet deep. This course is called a stream, and when it produces a large quantity of the metal it is denominated *Benhey*, which is a Cornish word signifying a living stream; and, in the same figurative language, when

the stone is but lightly impregnated with tin, it is said to be just alive; when it contains no metal it is called dead; and the heaps of rubble are emphatically called deads.

Tin Smelting.

The following description of the process by which Cornish tin is produced is taken from Dodd's 'British Manufactures,' pages 162, 164:—

"The ores found in veins and that of the stream-works are subjected to different processes of smelting, for they produce metal very different in point of purity. That obtained from mine tin is always of inferior quality, owing to the mixture of other metals, and which it is probable could not by any mode be got rid of; it is known in commerce by the name of common or block tin, and the quantity produced forms a large proportion of the whole that is brought to market. Stream tin produces a superior metal, known by the name of grain tin, which is principally used by the dyers and for the finer purposes. The first operation after the mine tin is brought to the surface, is to break it into pieces the size of a man's fist, and to reject such portions as do not contain more ore than will repay the cost of dressing, the first great operation in the smelting process.

"As the ore is sometimes so scattered through the stone as to be scarcely perceptible to the eye, the workman from time to time reduces a small quantity to an impalpable powder; and, by repeatedly immersing it in water and shaking it on a shovel, the heavier metallic particles separate from the lighter impurities, and in that way the quality of the ore is ascertained. The ore roughly broken, is taken to the stamping mill, which consists of several heavy upright wooden beams, shod with iron, and raised successively by wheels set in motion either by a steam-engine or water-wheel, and the ore passing beneath these beams in succession as it becomes smaller and smaller, and through sieves of various boxes under the surface of water, is at last brought to the state of coarse powder.

"This powder is now subjected to a great variety of washings and siftings, in all of which the purpose is to take advantage of the high specific gravity of the ore, and so to separate it mechanically from the lighter stony substances with which it is united in the vein. All these operations are conducted with more than ordinary care, for as the ore contains so large a proportion of valuable metal, it is important to guard against waste. But being sometimes mixed with other metallic ores which, from their specific gravity approaching so near that of the tin, cannot be removed by any process of washing, and these being for the most part decomposable by heat, the pounded ore is roasted in furnaces with a moderate and regular fire. After which it is again washed, and the tin ore, which is unalterable by that low heat, is obtained in a greater degree of purity.

"It is now in a state to yield from fifty to seventy-five per cent. of metal, and it is then sold to the smelter, who determines its value by assaying a sample carefully taken from the whole quantity.

"The smelting-furnaces hold from 12 to 16 cwt. of ore, and this is mixed with certain proportions of coal and slacked lime.

"The ore is an oxide of tin; the carbon of the coal unites with the oxygen, and thus the metal is set free, the lime acting as a flux to assist the melting. The heat employed is a very strong one, and such as to bring the whole mass into fusion, and is continued for 7 or 8 hours.

"The liquid tin is run off into an iron kettle from a hole in the bottom of the furnace, leaving the slag or impurities behind.

"The tin is ladled into moulds to form plates of a moderate size to be refined by an after process. The impurities still adhering are generally iron, copper, or arsenic, and these are separated by fresh meltings and exposure to heated air; and then the pure tin is cast into granite moulds capable of containing somewhat more than 3 cwt. each.

"These are called blocks, and are sent, according to the provisions of the Stannary laws, to be stamped (or coined as

it is termed) by the Duchy officers, and it then comes to market under the name of block tin.

"The stream tin ore, after being dressed by poundings and washings, is carried to a blast furnace, where, being mixed with wood charcoal, it is subjected to a very powerful heat urged by bellows moved by an engine. The melted tin is received in an iron kettle under which there is a gentle fire, and it is kept in agitation by plunging pieces of charcoal which have been soaked in water into it, and which by means of an iron tool are kept at the bottom of the kettle, the water in the charcoal is rapidly converted into vapour, and so the agitation is kept up, and any impurities in the tin are thrown up to the surface and skimmed off, and then the metal, which is peculiarly brilliant in appearance, is removed by ladles into moulds to form blocks: this is grain tin."

Adulteration of Tin.

It appears from the following extract, taken from the 'Gallery of Art and Nature,' that in early times dishonest traders were accustomed to adulterate tin with lead, and that the Dutch made a fraudulent use of counterfeit stamps to pass off this adulterated tin for English:

"The natural variety in the purity of tin, though sufficiently discernible, is far less than that which is fraudulently introduced.

"Tin is more than five times as expensive as lead, and as a mixture consisting of a large portion of tin with a small one of lead cannot easily be distinguished from a mass of pure tin, the temptation to adulterate is great and the fear of detection small. In Cornwall the purity of tin is ascertained before it is exposed to sale by what is called its coinage, the tin, when smelted from the ore, is poured into quadrangular moulds of stone containing about 320 lbs. weight of metal, which when hardened is called a block of tin. Each block of tin is coined in the following manner: The officers appoined by the Duke of Cornwall assay it by taking off a piece of one of the under corners of the block,

partly by cutting and partly by breaking; and if well purified they stamp the face of the block with the impression of the seal of the Duchy, which stamp is a permission for the owner to sell, and at the same time an assurance that the tin so marked has been purposely examined and found merchantable."

This rude mode of assay is not wholly improper, for, if the tin be mixed with lead, the lead will by its superior weight sink to the bottom, and thus be liable to be discovered when the bottom corner of the block is examined. But though the seal of the Duchy may be some security to the original purchasers of block tin, it can be none at all to those foreigners who purchase our tin from Holland, for if we may believe an author of great note, "in Holland every tin founder has English stamps, and whatever his tin be, the inscription, block tin, makes it pass for English."

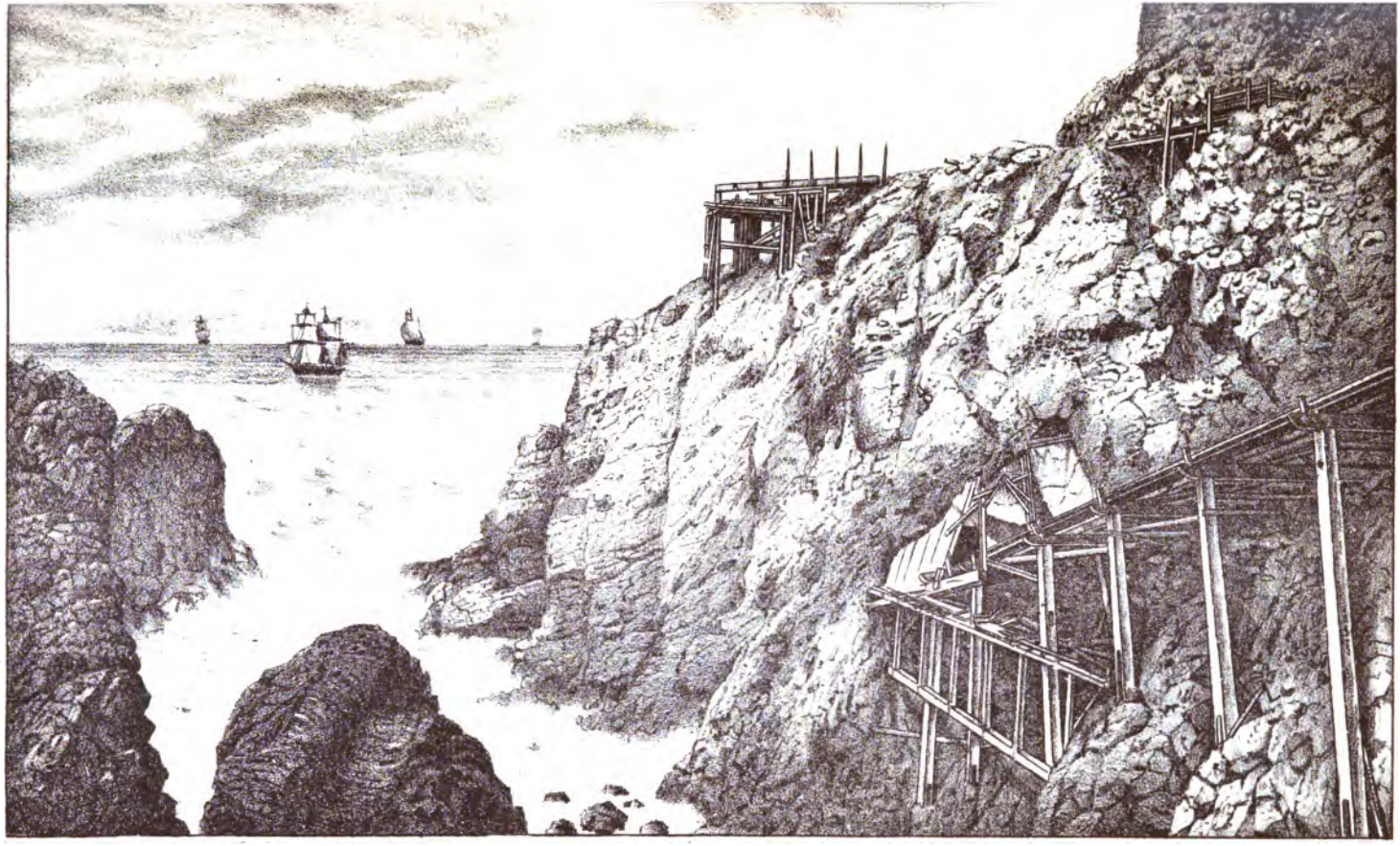
"In buying and selling the fault of the Dutch
Is giving too little and asking too much."

Submarine Tin Mines.

It is a most remarkable fact that, in the eager search for tin, some of the Cornish mines have, in defiance of danger, been carried to a considerable distance beneath the sea. The following description is given of the mine Huel-Cok in the parish of St. Just:—

"In some places the miners have only three fathoms of rock between them and the sea, so that they hear very distinctly the movement and the noise of the waves.

"The loudness of this noise is sometimes terrible, as the Atlantic Ocean is here many hundred leagues in breadth. In the mine the rolling of the rocks and stones overhead, which the sea moves along its bed, is plainly heard, the noise of which, mixed with the roaring of the waves, sounds like reiterated claps of thunder, and causes both admiration and terror to those who have the curiosity to go down. In one place where the vein was very rich the miners searched it



VIEW OF BOTALLACK, A SUBMARINE TIN MINE.

with imprudence, and left but four feet of rock between the excavation and the bottom of the sea. At high water, the howling of the waves is heard in this place in so dreadful a manner, that even the men who work near it have often taken to flight, supposing that the sea was going to break through the weak roof, and penetrate into the mine."

Use of Divining-Rod.

Reference is to be found in many old works to the *virgula divinitoria* or divining-rod, employed to ascertain the most favourable spot for sinking a mine, a superstition not confined to the ignorant and illiterate, but extending to the best informed; the use of this rod was introduced by a Spaniard named Riberea, in the reign of Queen Anne, and the following description is to be found in 'Manufactures in Metal,' vol. xi. p. 11:

"The rods formerly used were shoots of one year's growth that grew forked; but it is found that two separate shoots, tied together with some vegetable substance, as pack thread, will answer rather better than those which are grown forked, as their shoots being seldom of equal length or bigness they do not handle so well as the others, which may be chosen of exactly the same size.

"The shape of the rods thus prepared will be between two and a half and three feet long. They must be tied together at their great root ends, the smaller end being held in the hands.

"Hazel rods cut in the water, such as are used for fishing rods, and kept till they are dry, do best, though when these are not at hand apple-tree suckers, rods from peach trees, currants, or the oak, though green, will answer tolerably well. It is very difficult to describe the manner of holding and using the rod, it ought to be held in the hands, the smaller ends lying flat or parallel to the horizon, and the upper part in an elevation not perpendicular to it but seventy degrees.

"The rod, being properly held by those with whom it will

answer, when the toe of the right foot is within the semi-diameter of the piece of metal or other subject of the rod, it will be repelled towards the face and continue so while the foot is kept from touching or being directly over the subject, in which case it will be sensibly and strongly attracted, and be drawn quite down.

"The rod should be firmly and steadily grasped, for, if when it hath begun to be attracted there be the least imaginable jerk or opposition to its attraction, it will not move any more till the hands are opened and a fresh grasp taken.

"The stronger the grasp the livelier the rod moves, provided the grasp be steady and of an equal strength."

Future of Tin.

Having thus narrated so much as to the past and present, let us say a few words as to the future of our tin supply, which is eminently an uncertain one, depending as it does upon the issue of the struggle which is now in progress between the old world and the new—a struggle for life—which time alone can settle.

The good old county of Cornwall, which almost from the beginning of the world has been yearly extracting tin and yearly disposing of it to all comers up to the present time, shows not the slightest sign of exhaustion, but, on the contrary, is now producing nearly double the quantity of even twenty years ago.

The discoveries of 500 years since in Germany, which never became important, are now practically abandoned. Cornwall safely defies all competition from Europe and the East, but the cloud which threatens her rises in the South.

In the year 1760 as has been seen, the Dutch first imported a total of some 300 tons from the island of Banca, and, later on, the first arrivals of Malacca tin were received in England from Singapore.

Year by year these shipments have been gradually increasing, till, in 1872, the total of foreign tin raised amounted to

15,500 tons against a total produce of 10,000 tons from Cornwall.

Banca sold in Holland, 1872	3,000
Produce of the Billiton Mines, 1872	3,000
Straits exported from Penang and Singapore, 1872 .	9,500
	15,500

and of this large production of foreign tin more than half, say about 8300 tons, was sent to London to find a market.

Nevertheless, in spite of these ever increasing supplies, the increased demand for home consumption, and the enterprise of British merchants, found a use or a market for all that arrived, and there had been rarely, if ever, an excessive supply of tin.

In the year 1872, however, large discoveries of surface tin ore occurred in Queensland and New South Wales, and all at once a new supply appeared to find a sale in Europe.

The arrivals of Australian tin in London from next to nothing in 1872 increased to 3000 tons in 1873, and to 6000 tons in 1874.

These heavy quantities turned the balance against the Cornish and Eastern producers, who up to this point had been making the best use of their time and opportunities to enforce excessive prices from consumers, but now increasing stocks and falling prices soon plainly told the tale of "too much" tin.

			Tons.		
April	1873	Stock	8000	Price	£140
February	1874	„	9000	„	105
August	1874	„	10,000	„	94
January	1875	„	12,000	„	92
May	1875	„	13,000	„	82

The future of our tin supply is now a question of cost; there is no favour in trade, and whichever nation can produce the most cheaply must eventually command the markets of the world.

The Cornishman slaving away for ages, miles and miles beneath sea and land, has hitherto been successfully fighting

a battle with Dutch convict labour in the islands of Banca and Billiton, and with rice-fed, linen-clothed natives of the China seas.

But Englishmen are now challenged by Englishmen, Cornishmen are face to face with Cornishmen, the red-shirted diggers on the Australian plains, with their tin dishes and rough appliances, are already producing more than half the total quantity which is raised in Cornwall. It remains for history to show whether, assisted as no doubt these diggers soon will be by all the advantages of improved machinery which British enterprise and capital can and will supply, the Southern World beneath our feet, so highly favoured by the gifts of nature, will not eventually obtain and control the trade in this ancient metal which for 3000 years continuously has brought wealth and prosperity to the British Islands. "Che sarà sarà."

MAP OF SAXONY.

HISTORY OF TIN-PLATES.

CHAPTER III.

ORIGIN IN BOHEMIA—INTRODUCTION INTO SAXONY—JOURNEY OF MR. YARRANTON—ESTABLISHED AT PONTYPOOL—HEMMING'S PATENT—BIOGRAPHY OF MAJOR HANBURY—INTRODUCTION INTO FRANCE—IMPROVEMENTS—EARLY ACCOUNTS OF THE MANUFACTURE.

THE particular town or village in Northern Germany where the manufacture of tin-plates originated, and the actual year in which it was commenced, are unknown, but it has been very clearly ascertained that, in 1620, the trade had already existed for many years in Bohemia.

In that year a knowledge of the manufacture was sought and obtained from Bohemia by the then Duke of Saxony, who immediately commenced the manufacture in his own territories, and it was from Saxony that the secret came to England in the year 1670. The affair was at once taken up at Pontypool, but, in consequence of difficulties which shall be hereafter explained, was subsequently abandoned and neglected for a period of fifty years, and it was not till the year 1720, in the reign of George I., that the manufacture of tin-plates was finally established in this country.

From time immemorial, then, up to 1720, our ancestors were accustomed to import these tin-plates from Hamburg, but, as we have said, there is no record of the *invention* to be found in any of the French, German, or English works on metallurgy, and it seems to be probable that all information relating to this trade was kept very secret with a view

to a quiet enjoyment of the monopoly by those who possessed a knowledge of its details.

This idea is confirmed by the celebrated M. de Réaumur, who, writing on this subject in 1725, shows that the art of making tin-plates was considered as Germany's own trade. "It is said that it was a secret kept there very carefully; but where is the country and which is the trade where workmen are not mysterious?

"Limited in their understanding to a knowledge of what is necessary to obtain their own living, they think it very clever to know at least something of which other people are ignorant.

"However, there are arts which are open to every one and processes which can keep themselves from sight, and such are to be found in every country.

"The processes of making tin-plates are of this last category, but at the same time are they such as could not be discovered if the effort was made?"

The records of German mining are unreliable and imperfect, but it may be considered certain that the manufacture of tin-plates was commenced in Bohemia between the dates 1240 and 1600, following the discovery of tin mines in the Erzgebirge Mountains in the former year by a Cornish tin miner, who fled or was banished from England, some say on account of his religion, others for murder.

If he had committed murder, impossible as it is for posterity to forgive this nameless wandering assassin (to whom, however, a statue was erected at Awe in Saxony), we must, nevertheless, be ever grateful for the immense advantages which resulted to the world, and especially to this country, from (let us hope) the "accident" which obliged him to leave Cornwall.

As has been previously very briefly explained, from the time of the invention of tin-plates up to the year 1620, the manufacture existed exclusively in Bohemia, and the Bohemians supplied not only England, but the whole of Europe with tin-plates. In that year the reigning duke of the adjoining kingdom of Saxony, who is said to have been a wise

and far-seeing prince, willing and ready to improve his own revenue and the condition of his subjects, made an effort to obtain from Bohemia such a knowledge of the trade as would enable him to fix the manufacture in his own territories.

A Romish priest, turned Lutheran, was employed as a spy or "medium" in this affair, and with great success, for when Yarranton visited Saxony in 1605, less than fifty years after the introduction of the trade into Saxony, he found the different establishments very numerous and the trade a very profitable one, for he informs us that these tin-works have proved so beneficial to the place that there are several fine cities raised from the riches therefrom.

The situation certainly appears to have been a most desirable one, and the trade to have prospered, favoured by nature as also by the "providence of passing events."

The works, which were most of them owned by the Duke, were situated in a large tract of mountainous land on a great river, flowing along a valley for twenty miles from a place called Segar Hutton into a town named Awe, and some upon the rivulets which ran down the mountains.

Tin, iron, and charcoal were all obtained from the mountains ranging on both sides of this river, and the trade must have been a very important one, for Yarranton computes that no less than 80,000 people depended upon it for support.

In speaking of a population of 80,000, Mr. Yarranton no doubt includes wives, children, and shopkeepers who depended upon the actual workmen for their living.

If we calculate that there were three at home for one at work, the number of workmen will be reduced to 20,000; some engaged in tin mining and tin smelting, others in wood cutting, charcoal burning, iron ore raising, smelting, forging, boating, and hauling, in addition to those employed in the actual manufacture of tin-plates.

But even 20,000 men would be a very large number to find employment from one trade exclusively, and it seems possible that Mr. Yarranton was referring to the population who depended upon these and the other works of the Duke of Saxony for support, for he informs us that "the

Great Duke of Saxony hath three great manufactures: one of iron, tin, and copper; another of linen and spun threads of all sorts; the third of sawed timber of all sorts. He hath convenienced them thus: as to his iron, tin, and copper, he hath fixed these works in the valley running from Segar Hutton, clear along by the cities of Anaburgh, Sneburg and Wareauburg, and down as far as Awe, and in the hills and mountains are his minerals. In the valleys are the rivers whereon are set the works. The hills and mountains for at least ten miles round are full of woods to supply his works, not one acre of common land lies waste. At the descent of the hills, are infinite saw mills that go by water, which saw all manner of fir and oak, and in the summer time, it is dragged to the River Elbe, and so sent down to Hamburg; and things being thus fixed with all the advantages that trade can desire, that place is strongly populous and vastly rich, and yields to the Duke a great revenue, and it lies as Wales and as the Forest of Dean doth to England."

In contrast with this prosperous state of things in Germany the iron trade of this country was at that time (1625) in a most unsatisfactory and languishing state, the use of pit coal for iron-making had not then been discovered, wood for charcoal-burning had become excessively scarce and dear; English made iron was undersold in the London market by iron imported from Sweden, Germany, and France. Swedish bars were selling at 13*l.*, and French nail rolls at 15*l.* per ton in London, the iron workers were being thrown upon the parish for support, the ironmasters were reducing their stocks and their establishments.

The tin miners in Cornwall were also at this particular time suffering almost greater depression than that of the iron trade, and great distress existed amongst the 60,000 people who depended upon the tin trade for support, some of the workmen being positively in want of food and sustenance, and some of the employers being very short of money, although actually possessed of important quantities of tin, which to all intents and purposes was valueless until it was coined or stamped, which was only possible twice in the year.

The price of tin had fallen from 100*l.* to 90*l.*, and from that to 60*l.*, and, altogether, both the iron and tin trades were very much depressed when Mr. Yarranton formed the happy idea of making his voyage of discovery to Saxony.

There was moreover a very good reason at that period for extending and improving our manufactures. Yarranton foresaw very clearly that, with increase of trade would come increase of wealth, and that with more money would come better means of resisting the Dutch; for the great desire of his life was to deprive Holland of that trade by which the Dutch had become so fabulously rich and prosperous, and at the same time so powerful that, to use Mr. Yarranton's own words, "They had at last dared to face old England herself, and flaunting their new-born flag on the waters of Father Thames, had burnt our ships at Chatham." If he could only have lived to see the day no doubt he would have been very much gratified to find that we not only learnt our trade very well, but, in this year of grace, 1875, we are producing tin-plates at the rate of 3,000,000 boxes or 150,000 tons per annum, supplying the whole of the known world with this commodity, and exporting 20,000 boxes annually to Hamburg, from which port, when Mr. Yarranton lived and wrote, we were actually receiving our supplies of tin-plates.

Speaking of himself, Mr. Andrew Yarranton informs us that, knowing the usefulness of tin-plates and the goodness of our metals for that purpose, he had determined to find out the way of making them, and having put himself in communication with a person of much riches and one that was very understanding in the iron manufacture, who was pleased to say that he had often designed to get that trade for making tin-plates into England, but never could find out (by any) the way of making them.

It was agreed that a sum of money should be advanced by several persons to defray Mr. Yarranton's charges for travelling to the place where these plates were made, and for bringing away the art of making them.

Mr. Yarranton was commissioned by the following noblemen and gentlemen:

Sir Walter Kirkham Blount, Baronet;
Sir Samuel Baldwin, Knight;
Sir Timothy Baldwin, Knight;
Philip Foley, Esquire;
Thomas Smith, Esquire;
Thomas Foley, Esquire;
Joseph Newbrook, Gentleman.
Samuel Whyte, Gentleman;
Nicholas Baker, Gentleman;
John Finch, Gentleman;
Nicholas Harrison, Gentleman.

An able fireman, who well understood the whole nature of iron, was selected to assist him in the affair, and accompanied by an ingenious interpreter, who was well acquainted with the German language, and who, moreover, was accustomed to deal largely in foreign tin-plates, this well-arranged party made its memorable start for Germany in 1625.

They went first from England to Hamburg, thence to Leipzig, from thence to Dresden, where, at the Court of the Duke of Saxony, they were very well received and furnished with full information as to the places where these plates were made.

Proceeding on their journey they arrived at the works, where, contrary to their expectations, they were very civilly treated and had much liberty to see and study the manufacture, and were allowed to examine the materials employed in preparing the plates for tinning as well as the mode of turning them when cleared from their rust and blackness; they were also allowed to watch the workmen, and study the method of working and extending the sheets.

They found the works to be very numerous, most of them owned by the Duke of Saxony and some few by the Emperor, and the situation was most favourable for the manufacture. The works, which were situated in a large tract of mountainous land, were placed upon the river which divides

Saxony from Bohemia, tin, iron, and charcoal being found in abundance in the immediate neighbourhood.

The tin-plates, when made and ready for sale, were dragged from the works to the river Elbe, a land carriage of at least fifty miles, a great part of it very hilly and mountainous; and when arrived at the Elbe they were taken down the river to Hamburg, several customs being levied on them by the way, and from Hamburg they were sent by sea as far as trade was known.

Having (as they judged) sufficiently obtained the whole art of making and tinning the plates, they returned to England, where the several persons concerned in the affair thought fit to make some trial by tinning small quantities of plates. Several parcels were made, and sent to London to the tinmen for trial and approbation; and many were sent to Worcester to be wrought up by a tinman there.

"And all workmen that wrought upon them agreeing that the plates and the metal they were made of was much better than those plates which were made in Germany and would work more pliable and serve for many more profitable uses than the German plates would do. Upon which, preparations were made to set this beneficial thing at work for the improvement of our own minerals and setting the poor at work."

This first attempt to manufacture on a small scale was made at the village of Pontypool, in Monmouthshire, which was then, and has been ever since, the property of the Hanbury family, who were at that period themselves engaged in the manufacture of iron.

As soon as it was understood in London that the affair was successful, and that Yarranton had succeeded in producing satisfactory tin-plates, efforts were made by others to obtain a patent, as to the injustice of which Yarranton very bitterly complained, stating that the patentee was countenanced by persons of quality and that he himself was deserted by the ablest of his partners who was unwilling or at least afraid to offend great men in power, who had their eye upon him.

Thus, on account of the patent and a want of material

support, the manufacture was not persevered with by Mr. Yarranton's party, nor, as he says, possibly could be by him who had the patent, for he could not produce one single plate fit for use, "Sic vos non vobis."

This patent, which was dated in 1691, was granted in the following terms to an impostor named Hemming:

"A.D. 1691. *Specification, No.* 282.

"MANUFACTURE OF TINNED PLATES, HEMMING'S PATENT.

"William and Mary, by the Grace of God, King and Queen of England, Scotland, France, and Ireland, Queen, Defender of the Faith, etc., to all to whom these presents shall come, Greeting:

"Whereas Edmond Hemming hath by his humble petition represented unto us that he has at his great care and expense found out an art or invention for 'Making of Iron-plates Tynned over commonly called Tynned plates as good as those brought from and made in Germany which Invention hath not yet been heretofore known or practised by any of our subjects and hath prayed us to grant him our letters-patent for the sole use thereof dureing the terme of 14 yeares.'

"Know ye therefore, etc."

A full copy of this document will be found in the Appendix.

In consequence of this contretemps things remained *in statu quo*, and Germany enjoyed the monopoly of this trade for another forty years at least. This state of things, however, was not always to continue, there was money to be made and Englishmen to make it.

In the year 1720, memorable as the year of the South Sea Bubble, the trade was revived at Pontypool, nevertheless it does not appear to have been one of the mad schemes for which that year was so famous, there is no mention of it to be found in any of the lists of bubbles, and this honest trade was certainly able to hold its own and to extend itself when the other schemes of the year are only remembered for their extravagance and absurdity.

The works were at that time the property and under the management of Mr. John or Major John Hanbury, but it does not appear *by whom* the knowledge of this trade was brought for the second time to Pontypool; it seems to be certain, however, from the dates, that the management of the manu-

facture could not have been undertaken either by the unlucky Mr. Yarranton or by any of his associates.

Supposing that Yarranton was twenty-five years old when he left England for Germany in 1670, he must have arrived at the age of seventy-five in the year 1720 and it is most improbable that, even if he had been still alive, he would at such an age have again attempted to fight his way through all the difficulties inseparably connected with such an undertaking.

Attracted to Pontypool as it doubtless was by the water-power, as by the abundant supply of excellent and suitable iron, the trade under the able management of *Major Hanbury* soon took a firm hold. The discovery of sheet iron rolling followed in 1728, an invention claimed alike by John Payne and by Major Hanbury, and it was in a great measure owing to this improvement that we were enabled to turn the tables upon Germany.

The tinmen were greatly delighted with the English plates, the colour was better and the *rolled* plates were found to be more pliable than the foreign ones which were hammered, for it was and is impossible to hammer either iron or copper to so uniform a thickness as that to which they are reduced by being rolled, which has been well described as "The Art of expanding Bars by compressing Cylinders."

It thus appears, then, that England is indebted quite as much to Major John Hanbury as to Mr. Yarranton for the establishment of the tin-plate trade in this country, and at this point it may not be out of place to give the following biography of the Major, which is to be found in Coxe's 'Historical Tour,' and to present his portrait (supposing the *red* cap), which is also taken from the same work, copied, as Mr. Coxe has stated, in the first instance from a family portrait at Pontypool.

"MAJOR JOHN HANBURY.

Capel Hanbury's eldest son and heir, John, usually known by the name of Major Hanbury, was born in 1664. After

receiving a liberal education, and attaining considerable proficiency in classical literature, he chose the profession of the law. He did not, however, long pursue his studies in this line. He said one day to Mr. Jones, of Lanarth, I read Coke upon Littleton, as far as Tenant in Dower, but on the suggestion of a friend that I should gain more advantage from the iron works of Pontypool than from the profits of the bar, I laid aside Tenant in Dower, and turned my attention to mines and forges.'

In 1701 he married Albina Selwyn, daughter of John Selwyn, Esq., of Matson, in the county of Gloucester, with whom he obtained a considerable fortune. With this addition to his own property, he determined still further to improve the iron-works at Pontypool, near which place he built a house and fixed his residence.

His skill and indefatigable application were crowned with considerable success: he increased the produce of the iron-works; made many improvements in the machinery; invented the method of rolling iron-plates by means of cylinders; AND INTRODUCED THE ART OF TINNING INTO ENGLAND.

By the interest of his wife's family he was chosen in 1701 member for the city of Gloucester, which he continued to represent in the three succeeding Parliaments. His wife dying without issue, he espoused, in 1703, Bridget Ayscough, eldest daughter of Sir Edward Ayscough, Knight, in the county of Lincoln; she was in high favour with the Duchess of Marlborough, and by this connection he acquired the protection of the Duke, who honoured him with particular marks of confidence and esteem.

On the accession of George I., he was returned by the independent interest, member for the county of Monmouth, which he continued to represent until his death. Although no speaker, he distinguished himself as a man of business, and was appointed chairman to several committees. During the reign of Queen Anne, and the early part of the reign of George I., he uniformly voted with the Whigs; but on the schism which divided that party, he joined the body hostile

to government, opposed the administration of Sir Robert Walpole, and his name appears among the members who voted against the excise.

In 1720 he obtained a considerable acquisition of property. Mr. Williams of Caerleon, who fled from his country for killing Mr. Morgan, of Penrose, in a duel, having received, on his return to England, great marks of attention and friendship from Major Hanbury, stood godfather to his son Charles, and, dying unmarried, bequeathed to him the bulk of his fortune, which exceeded 70,000*l.*, under the conditions that he should purchase estates, the proprietor of which should assume the name and arms of Williams. In memory of his benefactor, Major Hanbury erected a monument in Westminster Abbey with an elegant inscription expressive of his regard and gratitude.

Soon after the failure of the South Sea scheme, when many of the directors were dismissed, the integrity of his character and his talents for business recommended him to the proprietors, and he was appointed one of the new directors, and about the same period he had the honour of being one of the executors of his patron the Duke of Marlborough's will. In gratitude for his faithful discharge of that delicate office, the Duchess of Marlborough presented him with an elegant service of plate, and his wife with a valuable set of jewels.

Before his death he purchased the estate of Coldbrook, and settled it on his son Charles, godson of Mr. Williams, afterwards well known under the name of Sir Charles Hanbury Williams. He died highly respected, beloved, and lamented, in 1734, in the 70th year of his age. He left five sons, John, who died in 1736 without issue; Capel, the ancestor of the present possessor of Pontypool Park; Charles George, who succeeded to the estate of Coldbrook after the death of Charles and Thomas, who died in 1778 without issue.

Mr. Yarranton has left us no account of the DETAILS of the manufacture as he found it existing in Saxony, but he has contented himself with pointing out the very great advantages which would result to the iron and tin trades of this country from the manufacture of tin-plates as practised in Germany.

No account (so far as the writer has been able to ascertain) has ever been published in England, of the nature of this manufacture prior to 1720, and we are indebted to two French works for the descriptions which will shortly follow of the German processes, which were doubtless the same as those which were first introduced at Pontypool.

The first English account of tin-plate making is to be found in an excellent article written in 1818 by Samuel Parkes, Esq., addressed to a learned society in Manchester, and published with the records of that society.

Mr. Parkes prefaces his observations by stating that no accurate account has *ever* yet been given of the various processes by which the coating of iron is effected, &c., but he probably had no knowledge of the two French authors who, in 1725 and 1756, had described very fully the nature of this manufacture.

It will be seen, by comparing the several accounts which follow, that the English process described by Mr. Parkes in 1818, had been very greatly improved upon since the introduction of the trade from Saxony in 1720, and those who are conversant with the trade will recognize at once that the manufacture, without the improvements which followed, could never have been carried on to any great advantage or, at all events, could never have arrived at any degree of importance.

What should we do to-day, if we had to RETURN to the old system of hammering out iron, sheet after sheet, by means of a water-driven slow moving hammer, smothering the plates up in hot charcoal every now and then to anneal them, steeping them for three times, twenty-four hours in tanks full of rye meal and water in underground vaults heated by fire to such a degree that only naked men could work there.

The most important improvements and alterations were, first, the introduction of sheet-iron rolling in 1728; then the use of a grease-pot to prepare the iron for coating in 1745, the use of hydrochloric acid as a substitute for barley meal in 1760; the use of grooved rolls for bar-rolling in 1783; and the annealing-pot, invented by Mr. Thomas Morgans in 1829, and from that date to the present (patent rolling for dipping

excepted), the improvements have been more in detail than in principle.

The French iron-masters were not much, if at all, behind the English in seeking to obtain a knowledge and a share of the trade which was bringing such wealth and prosperity to their neighbours in Germany.

There exists in human nature an uneasy restless feeling to escape when compelled by circumstances to purchase what one is better able to make for oneself.

Go where you will throughout the wide world and you will find in every class of life an indisposition to part with ready money in exchange for any article which can be better and more cheaply manufactured at home.

Setting aside the false start made in England in 1670 it appears that, Germany excepted, the first *successful* works for the manufacture of tin-plates was established at Mansvaux in Alsace in the year 1714, from six to ten years before the revival of the trade at Pontypool under the happy auspices of Major Hanbury in 1720–25.

Previously, however, to 1714, namely, between the years 1650 and 1680, two unsuccessful attempts had been made to establish the trade in France, one at Chenessy, in Franche Comté, and the other at Beaumont la Ferrière, in Nivernois.

These works were organized and started under the fostering care of M. Colbert (Jean Baptiste Colbert), the eminent minister of Louis Quatorze, who, recognising the importance and value of the trade, desired to establish the manufacture in France, and a third attempt was made at Strasburg, towards the end of the Regency.

These works subsisted for several years, but De Réaumur informs us that "these valuable workmen, not finding themselves supported by the intelligence and protection to which the trade owed its origin, had no success and withdrew."

The French nation, certainly, and possibly the English, are indebted to M. de Réaumur (who, like Mr. Yarranton, made a special visit to Germany) for the first sound practical information as to the trade; further on will be found a

verbatim copy of his dissertation as written for the Academy of Sciences, and published in Paris, 1725.

Mr. Parkes, in his treatise of 1818, before referred to, says that about the time when the works at Pontypool were established, the amiable and intelligent M. de Réaumur, to whom the French were indebted for the new mode of graduating the thermometer and other valuable improvements in the arts, undertook to discover the method of making tin-plates for the French people, and this eminent man, whose mind was cast in a mould very similar to that of Mr. Yarranton, but who possessed more science, and who never relinquished anything which he undertook, notwithstanding the innumerable difficulties which he had to encounter, succeeded in acquiring such a knowledge of the principles of the manufacture as enabled him to instruct several people in the art which, until then, had never been practised in that country.

Once, however, successfully started, the works at Mansvaux, in Alsace, were followed by those of Bains in Lorraine, 1733, under letters-patent from the Duke Francis III., confirmed in 1744 by King Stanilaus of Poland; Imphy, near Nevers, in 1745; Morambeau, in Franche Comté, 1751.

After the successful start at Pontypool, the manufacture began to extend itself through Wales, particularly in those situations where water power was available, and where forges already existed for the manufacture of charcoal iron, and from Pontypool it spread to Caerleon and Ponthir in Monmouthshire, to Ynisgerwn near Neath and Melin Griffith near Cardiff in Glamorganshire, and to Kidwelly and Carmarthen Town in the county of Carmarthenshire.

It would be useless if it were possible, and if it were useful it would be wearisome, to follow in detail for 150 years the various phases in the history of the trade: the main facts as to the increase of production, and as to the improvements of manufacture will be best explained—the former by the dated list of English works which will hereafter be given, and information about the improvements in manufacture will be derived from the description of the trade as existing at

the respective dates, at which the several accounts were published, viz.:

A dissertation by M. de Réaumur, published in Paris, 1725;

An illustrated account of the process in use at the Mansvaux works, Alsace, published in Paris, 1756;

An account of the manufacture as carried on in Bohemia, Saxony, and Sweden, published in Lyons, 1774;

A descriptive account of the English manufacture by Samuel Parkes, Esq., published in Manchester, 1818;

A paper on the manufacture prepared by Mr. Ebenezer Rogers, for the South Wales Institute of Engineers, 1857;

A detailed account of the manufacture, as carried on at the leading works of South Wales in 1875.

In the absence of any other history for a guide, the task of collecting and arranging the material has been an extremely difficult one, and the writer therefore hopes to be excused for any inaccuracies into which he may have fallen; but he believes that, if studied with care, the information presented will afford to the reader a continuous and reliable history (the first published) of the origin and progress of the Tin-Plate Trade.

CHAPTER IV.

DISSERTATION ON 'THE ELEMENTS OF THE ART OF MAKING TIN-PLATES,' BY M. DE RÉAUMUR, TRANSLATED FROM THE "HISTORY OF THE ACADEMY OF SCIENCES," PUBLISHED IN PARIS, 1725.

IRON is the metal which is most easily destroyed, it lies open to the weakest dissolvents, even common water attacks it with success. Sometimes a little moisture is sufficient to destroy the finest parts of the best polished works; in order to protect that which by its use is exposed to the action of water, it has been usual to cover it with different coatings, some are oiled, the most precious are gilded, some are bronzed—it has been thought of covering the commonest with tin.

In former times our locksmiths used to tin bolts, little bolts, locks, knockers of doors, as is still done in several foreign countries. Every day the bits and curbs of bridles are tinned; latterly, sheets of iron have been tinned, and those tinned sheets are what we call *White Iron.*

These tin-plates are suitable for many purposes — there is a considerable demand for them in France. We purchase them from our neighbours, who are selling to us a metal which we could furnish to them if they were in want of it.

The late M. Colbert the eminent Minister, who founded this Academy, took great care to establish tin-plate works. The information which he gave to a few people brought to the kingdom two of these works, one was established at Chenessy (Franche Comté) and the other at Beaumont la Ferrière (Nivernois). They existed for several years, and probably they would be flourishing now if they had been assisted by the same protection as that to which they owed

their origin, because fine and good tin-plates have been made in both works.

A few months since two different companies and two private gentlemen have solicited privileges for tin-plate works. Privileges have been granted to the two Companies and to one of the gentlemen. However, we have only found in one of the companies people who thoroughly understand the work. It is very much to be desired that these tin-plate works should increase in the kingdom, but they will only increase when they are conducted by people who understand the manufacture.

Moreover, the art of making tin-plates is looked upon as Germany's own: it is said that it is a secret kept there very carefully. But where is the country, and which is the trade in which workmen are not mysterious? Limited in their knowledge to what is requisite to get their own living, and perhaps proud of knowing at least something of which other people are ignorant, the little they do know they keep to themselves.

However, there are arts which are open to all comers; others have processes which can be kept from sight, and they are concealed in every country. The processes of making tin-plates are of this last category, but are they at the same time such that they could not be discovered if the effort were made?

It is at least a research that the interests of this kingdom required, and it is one which we will take up; this examination will enable us to discover in what consist the essential processes of this art, and to add a few ideas which perhaps will be useful to simplify and to improve.

We hope, at least, that after publication of this treatise, that people will not rank any longer the manufacture of tin-plates amongst the arts which are unknown to us, and that those who are willing to erect works will be able to conduct them and to improve upon the ideas which we shall have given.

We need not report the particulars of infinite methods which would too much lengthen a simple treatise, but we

shall not fail to give in another publication a full description of an art of which our present intention is to describe the elements.

The working of the tin-plate only begins, properly speaking, when the sheets of iron are ready to be tinned. We must suppose them to be flattened enough and cut square, they are then called black-plates. There are only certain kinds of iron which can be reduced into sheets. The most fit are those which stick well when warm and which bend well when cold, iron which breaks when cold must be rejected. Iron which is extremely flexible when cold would not be suitable; the sheets of black or tinned plates, although thin, must be strong and have a certain degree of spring; sheets made with excessively soft iron would not have enough spring, they would be too much like lead sheets; happily, we have the choice in this kingdom of any quality of iron.

There is no secret in the fabrication of black-plate; it would be useless to explain how these sheets are made from iron bars about $1\frac{1}{16}$ inch square; how, after being flattened a little, they are cut into pieces which are called soles; how these soles are bent in two; and, finally, how bundles containing 40 sheets are made which are beaten all together under a hammer weighing 660 to 770 lbs.

We shall suppose then that the sheets of black-iron are finished and that it is only necessary to render them white, that is to say, to tin them. The secret of the art, and what is most desired, is to tin the plates at a small cost, because nothing could be easier than to tin a small quantity of sheets without regard to the cost.

Tin has a marvellous disposition to stick to any other metal; it is sufficient to rub a piece of iron with a little sal-ammoniac, and to dip it into melted tin: when it is taken out the tin covers it everywhere, that is to say, it sticks all over the surface. Why, then, is there any difficulty in tinning sheets of iron? It is because it is only to pure iron that tin adheres; if any dirt, any powder (however light), covers the surface of a sheet of iron, or if there is the slightest portion of

rust, the tin will not unite with iron dipped in melted tin. But if one files the surface of this sheet everywhere, so that it takes the white colour which is the character of the most suitable kind of iron, and if one rubs it with sal-ammoniac and dips it into melted tin, one may take it out afterwards properly tinned. But filing and the use of sal-ammoniac would render tin-plate too dear, not that sal-ammoniac would cost too much, because very little is wanted, but it very often spoils the white colour of the tin which adheres to the iron: it produces dirt, which is unimportant for goods which must be filed or polished after tinning, but which would spoil our sheets of tin-plate which do not want either filing or polishing.

Our art has then two principal objects: the one is to render the sheets fit for tinning at a small cost, and the other to tin them perfectly.

To render the sheets fit for taking tin, instead of trying to make them smooth by numerous rubbings of files, it has been proposed to dip them into acid waters for a certain time. These waters achieve slowly, but at smaller cost, what the file would do immediately, they "gnaw" the surface. Besides, as many sheets are dipped at the same time, the effect of the waters is equivalent to a large number of files. When the sheets have been "gnawed" to a certain point they are taken out of the waters, rubbed and scoured with sand in order to remove all that remained on their surfaces, a woman scours in an hour more sheets than the cleverest workman can produce in a few days. The secret, which is the basis of tin-plate manufacturing, then, is reduced to taking the dirt away, or, in the terms of the art, to pickling in acid waters, and the important part of the secret is to pickle the iron in the waters which cost the least, and do not injure it in any way.

I have experimented with waters in which had been melted different salts and in different quantities, such as alum, vitriol, borax, sal-ammoniac, sea-salt, nitre; also strong waters weakened with common waters; also with liquors which contain natural acids such as wine, beer, and, still better,

vinegar, verjuice, pure or mixed with different quantities of water, in a word, as many acid liquors as I could think of, but it would be too long to describe them here, and it will perhaps be enough to notice the cheapest and strongest waters; I will only add that the waters which I experimented with contained all the acids which can be obtained from fermenting cereals. It is known that wine is sensibly acid.

I have tried the waters which derive their acidity from corn which had fermented, and I did not fail to do so, because (by anticipation) all the secret practised in Germany consists in sour waters made with rye. I knew it long before—fifteen or sixteen years ago. I travelled in order to see the tin-plate works of Beaumont la Ferrière (in Nivernois) which was still working, but near to its fall. I was spoken to in the ordinary mysterious manner, but they could not conceal from me that the pickling waters were made with rye; they only tried to make me believe that they added many other matters in the preparation of these waters. The first workmen of their manufactory were Germans, they had brought this process from their own country. All that we still hear from the German works does not allow us to doubt that it is the process now in use. These works are obliged to stop in the years when there is a dearth of corn.

It is only necessary to grind coarsely or to bruise the corn required to make the acid water, and the process of making them sour does not require much labour. The first are used for leavening; the second, once made, it is easy to multiply them. The first becomes sour sooner or later according to the process used, such as adding to these waters leaven, or other acids, or keeping it in warm places, but sour waters can always be obtained, when with a little patience the bruised corn is left to ferment in the water during a certain time. Our starch manufacturers give us proofs of this. When one goes near to the casks where starch is preparing, the sour smell is very active and disagreeable; these casks only contain water which has remained a few weeks over bran of wheat. What they want is to cause

the bran to ferment and make it putrid in order that the water may dilute the flour which is attached to it, and it comes out extremely thin. I have tried these same waters of the starch manufacture to pickle the iron—they have answered perfectly.

But rye, of all the cereals, is the most suitable for sour waters. When used to make bread, rye bread, although heavier than that from any other corn, has a slight acid taste, which the other breads have not.

In years when rye has been too dear, oats have been tried, but without so much success. In one word, any corn may be used for sour waters, but rye appears to be the most suitable. The process used is to fill casks with these sour waters, in which heaps of sheets of iron are afterwards placed.

To have the waters more sour, and in order that they may be more active, the casks are kept in hot houses, that is to say arched vaults, which are generally shut, and where large fires are burning. The workmen go once or twice a day into the cellars to turn the sheets over in order that they may all be, by turns, under the action of the acid; also to take out of the casks the pickled sheets, or to put in other sheets. It is painful work. The heat would not be tolerable if they were not gradually accustomed to it: they are quite naked there. The sheets are the soonest pickled which are put into the sourest liquor, or exposed to the greatest heat in the arched vault. They are kept there for at least two days, but sometimes a great deal longer.

Is this hard manner of pickling the iron the best? It is at present, but perhaps that which I shall propose, though less painful, will be more effectual.

As soon as the iron is dipped into the water, it is a good plan to heat the water; but is it best to begin by dipping the iron into the sour waters? people have tried to dissolve iron, and it is certain that, for a metal to be dissolved, it must be surrounded on all sides by the acid. If I had to dissolve a piece of iron that had been filed, I could readily do so. But our sheets of iron are not the same as filed iron, and if I

had to clean a piece of worked iron coated with varnish, on which acids which have an action over iron had but little effect, I would seek for the means of breaking this varnish to make it fall off.

Now the sheets of iron are really covered with such a varnish as we have just spoken of. Any iron, after having been quickly heated, if not filed, is covered with a coating on which acids have little or no effect. The surface of the iron has sustained a stronger heat than the interior of the metal—it has become burnt or half vitrified. Now this part can resist the same acids which will act on ordinary iron; it is then, so to speak, indissoluble.

It is known that sheets of iron kept during several years in damp warehouses have no rust, or almost none, compared with filed iron kept in the same warehouses. They have a bluish colour, easy to distinguish from the brown colour of rust. There is never any rust where this bluish colour is found.

Our sheets of black-plate then are covered with a shell, a slight coat of half vitrified iron on which acids have little or no effect. It is very likely that this coat, which is neither flexible nor malleable, has infinite cracks, which give way to the acid: first it digs at the iron in a right line, but afterwards it attacks it on the side, enters under the shell, and removes the shell as soon as it has gnawed the iron to which it was attached.

I dipped black-plates in several solutions, such as alum, salt, and sal-ammoniac, and took them out immediately to expose them to the air twice or thrice a day during two days, and I noticed that these sheets were cleaned more easily than the other sheets which remained plunged during the two days in the same dissolutions.

All these waters used for pickling are weak; more powerful solutions would cost too much, and our principal view is economy even at the expense of inconvenience.

As soon as the sheets have been pickled and cleaned by rubbing with sand, they are put into pure water till they are wanted for tinning, in order to preserve them from rust.

Active solutions, such as vinegar and vitriol, pickle better the iron which is kept immersed than the iron which is taken out immediately. Vinegar is certainly one of the best liquors for pickling. Its effect is quicker than that of corn water, and as its acid is analogous, it does not give any bad quality to the metal. It is so natural to use vinegar that there is no doubt it has been tried before using rye water, but it is likely that it was found too dear; the experiments moreover were doubtless dearer than they would have been in any country, as the first tin-plate works have been erected in the countries where wine is not common.

The following manner is, I believe, quicker and cheaper than using rye-water: it is only to dip every sheet in vinegar, then take it out immediately and put it in some damp place, the sheets will be pickled in less than forty-eight hours if this operation is repeated three or four times a day.

The pickling will be still more quickly done if a little sal-ammoniac is mixed with the vinegar.

Or the sheets might be dipped once or twice into vinegar, and when the vinegar was dry on the surface, common water might be poured on the sheets, or they might be dipped in water and taken out immediately.

We have said that vitriol pickled well and quickly enough. In the countries where pyrites is common (and it abounds in most countries), vitriol could be obtained very cheaply. It would be only necessary to collect pyrites, to leave it exposed to the air, and to soak it in water: this lie would be fit for pickling iron dipped into it.

Every sheet of black-plate has one side, which is much more difficult to pickle than the other; it will not take the polish of the first, and remains almost always marked with spots: the more the surface of iron has been burnt, the more difficult it is to pickle it.

As we have said a bundle of forty sheets is beaten altogether. The two sheets which form the outside of the bundle, receive the most severe blows of the hammer as the

bundle is turned, just like a flat bar which is forged. The manner of continuing to forge this bundle, requires that the sheets which were in the middle come successively uppermost, and thus every sheet has a side which is exposed immediately to the action of the fire, and to that of the hammer and of the anvil, a side more burnt and more planed than the other. It is very important to avoid this by constantly keeping the same outside sheets and changing them with spare ones, which are larger at each heating.

To avoid the soldering of the sheets of the bundle, they are dipped before beating, in clayey earth mixed with water. It would be well to add to this earth a little powdered coal.

The tin is melted in a large iron pot which looks like a pyramid, having four sides, of which two are smaller than the others. It is heated from below. It is cramped all around its upper edge. This pot is always deeper than the sheets are wide or long, they are dipped in it always vertically, never horizontally, and the tin must cover them.

Tinning in the same manner as in tinning locksmiths' work with the aid of sal-ammoniac, would cost too much, and many spots would remain on the sheet; moreover, the plates would rust after a certain time. We have seen a gentleman who first rubbed the sheets with grease, and the tinning was uniform, but with spots. Another way is to dissolve sal-ammoniac in vinegar, and dip the sheets into it just before tinning, but this is not so good as grease. Sal-ammoniac dissolved in water has also been used, but without much success.

Perhaps the sal-ammoniac beneath the tin which covers the iron has an action which at length alters the iron, as many sheets become rusty.

The method used for tinning in Germany, and in the works of France, is different from this. Skilful tinners do not use sal-ammoniac, and after pickling only dip the sheets in pure water. When the tin is melted, they cover it with grease; the sheet never goes into the tin without

having passed through the grease. This grease prevents the surface from being burnt.

They use a special kind of grease which is not of the usual colour, it is black. White, or common grease would not do; the composition of this grease is a secret kept by the tinners. I made a great many experiments about this: I mixed sal-ammoniac, soot, and lampblack with grease, and with these I succeeded, but still it was not quite the grease used by tinners, and I learned that their grease was only tallow which had been burnt. The cause of this difference between grease and tallow would be very interesting to know.

The tin in which the sheets are dipped must have a certain degree of heat. Too warm, it does not stick to iron, or sticks in large drops, or the coating is too thin, and the sheets are not white, but have red mixed with yellow and blue—in fact, are bad looking—but it is easy to make experiments to ascertain when the heat is at its true degree.

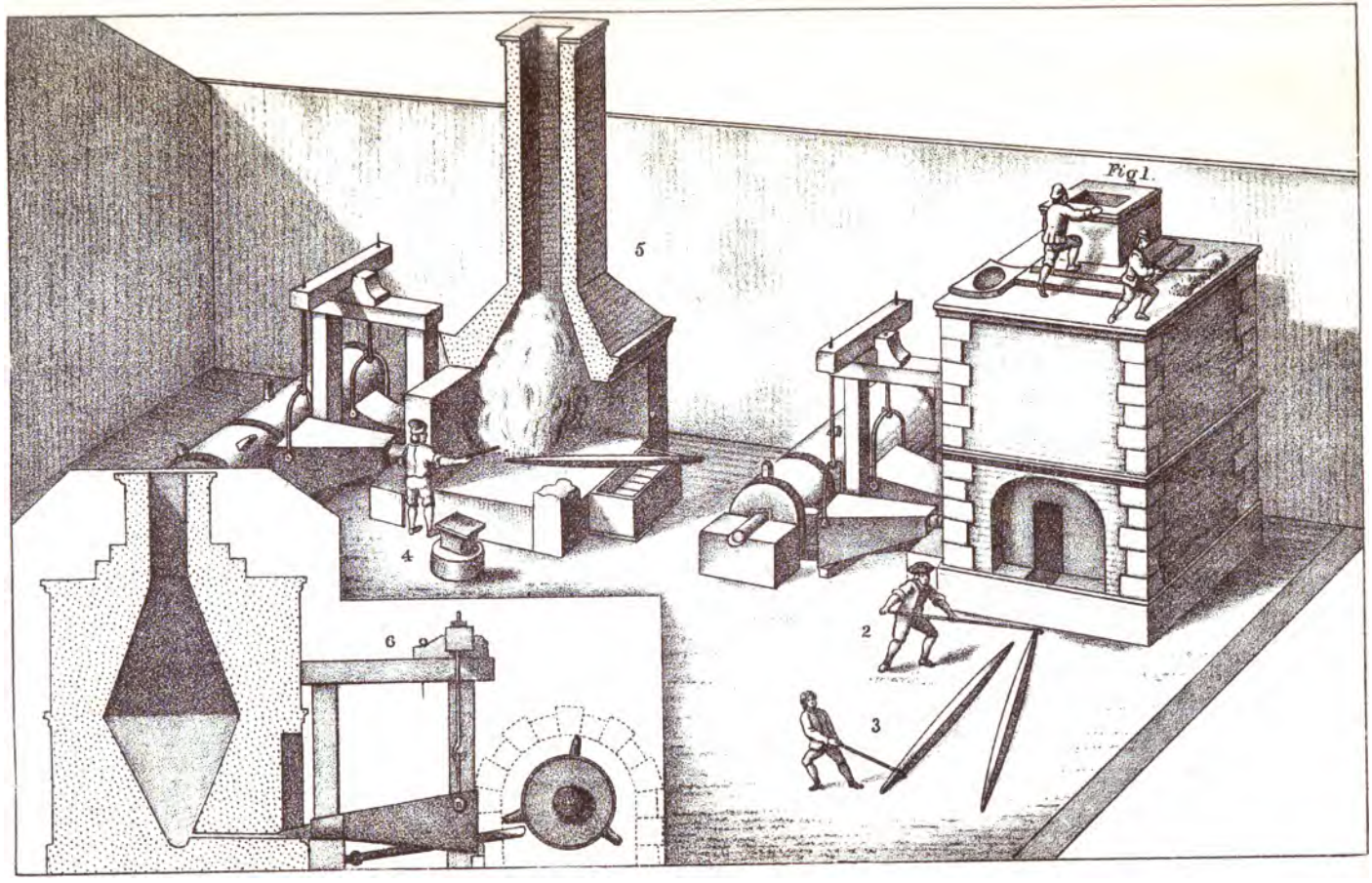
Some sheets receive a single coating, others have two coatings. The first bath for these last is hotter than the one that follows, otherwise the second dipping would be useless, as the tin would run off. This precaution is very important, for I have seen gentlemen who had obtained a privilege for the working of tin-plates who acted in an opposite manner. They first dipped the sheets in tin slightly heated, out of which they come with a too thick and gravelly coating; they afterwards dipped these sheets in tin extremely hot, to take this scruff away and diminish the coating.

The second pot in which the sheets are dipped must be covered with white grease, not black, as melted tin will stick well to solid tin. The choice of tin, the manner of making it as white as possible, and a quantity of little details shall be studied another time.

It remains to be seen whether the establishments in this kingdom will furnish tin-plates as cheaply as Germany; the carriage would be less for a certainty. But commencements are costly, workmen take a long time to learn,

and gentlemen who go into new enterprises want a large and immediate profit. They give it up if success does not come quickly enough for their greedy eagerness.

We certainly ought to do without the German tin-plates, but perhaps we shall not be able to do so for a long time if the Court does not give to the first works a similar protection to that granted by M. Colbert.



MANUFACTURE OF BAR IRON IN FRANCE, 1714.

CHAPTER V.

DESCRIPTION OF THE MANUFACTURE AT MANSVAUX, ALSACE, ESTABLISHED 1714, A TRANSLATION FROM THE 'ENCYCLOPÉDIE OU DICTIONNAIRE RAISONNÉ DES SCIENCES, DES ARTS ET DES MÉTIERS PAR UNE SOCIÉTÉ DE GENS DE LETTRES,' PUBLISHED BY M. DIDEROT, PARIS, 1756.

THE iron is brought to the works in little bars, the best is that which is ductile and soft, and which forges well when cold, but it is not essential that the iron should have these qualities in excess.

The bars are heated in furnace A, they are then slightly hammered out on anvil B, afterwards they are placed under the big hammer C, where they are cut into two pieces, which are called "semelles" (sole of a shoe).

The semelle produces two sheets of tin-plates, d, d, d, which are first heated until they sparkle violently in forge A; then they are roughly reheated, then they are hammered a third time and finally placed again under the same big hammer C until they are almost double their first dimensions, after which they are doubled up according to their length.

Next they are dipped in water which contains a sandy earth, to which it is well to add some charcoal dust; the effect of this immersion is to prevent adhesion.

When a large quantity of these sheets doubled in two has been prepared, they are carried to furnace S, where they are placed vertically side by side on their edges on two bars of iron, which support them, and thus they form a pile varying in size according to their thickness. This pile is called "une trousse."

A lever of iron, which can be raised or lowered according to circumstances, serves to hold this trousse or bundle tight, it is then surrounded by very large pieces of charcoal, which are ignited.

When he considers that the bundle is sufficiently heated, a workman takes a packet or trousse of forty of these double sheets and places them under the hammer. The second hammer is larger than the first, it weighs 700 lbs. and is not so sharp. Here the packet is beaten until the sheets have acquired their proper dimensions, and it may be noticed that the outside sheets, namely, those which touch the anvil and the hammer, are not stretched so much as those which are shut up between them, for the inside sheets retain their heat the longest, the outside sheets require more heat and more hammering.

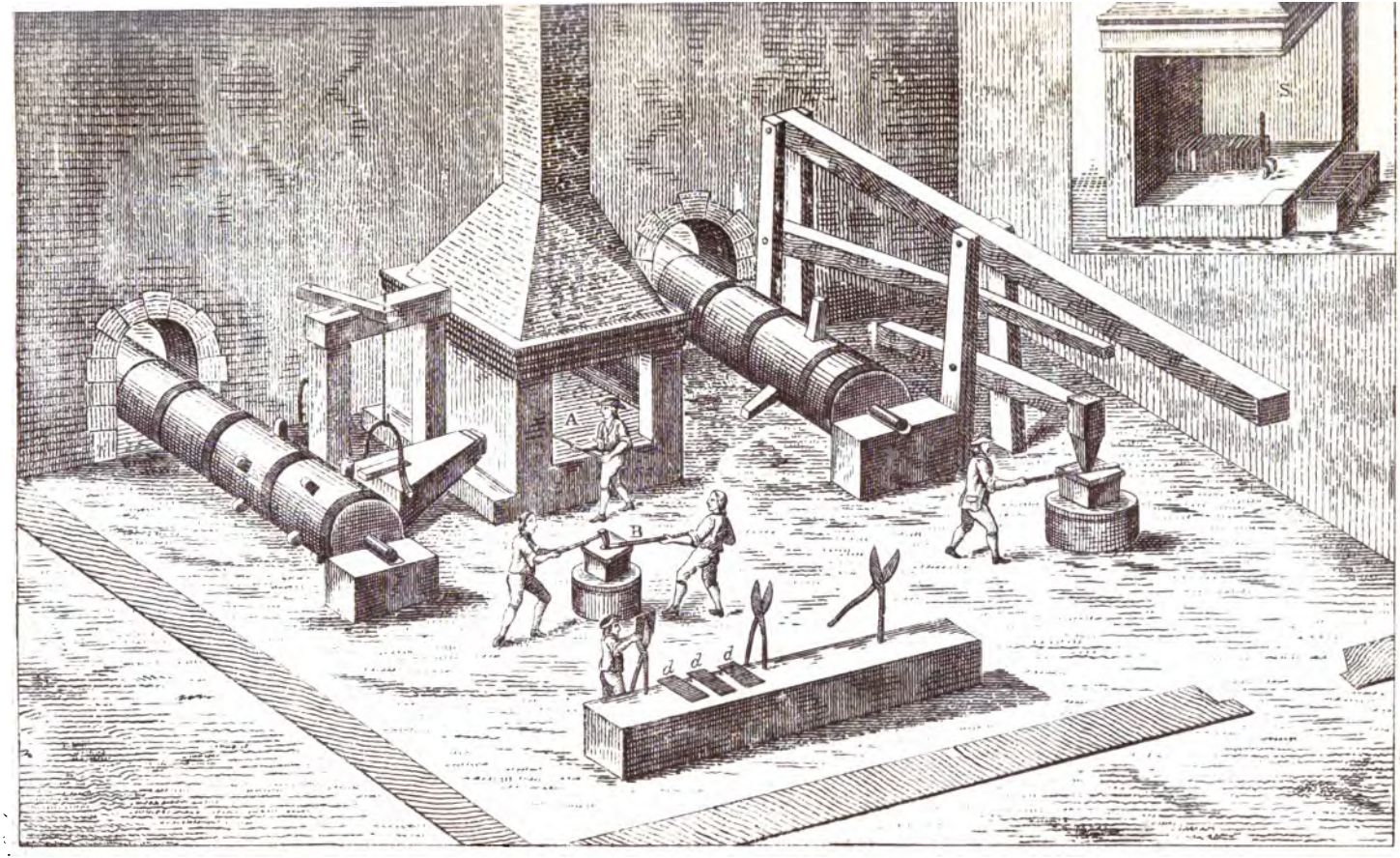
After this first operation they place between the sheets those which in the previous operation had not been sufficiently stretched; thus they perform the same operations on all the packets or trousses.

Then the intermixed packet is placed on the fire and heated again. When the plates are sufficiently heated they are taken out of the fire in packets of about 100 sheets each, they divide these packets into two equal parts and arrange them in such a manner that those which were formerly on the top are placed beneath.

They are carried in this state to the big hammer, the trousse is beaten out, more waste sheets are intermixed, then they take them to the fire, and then out again, after which each packet is divided into two parts as before; they are again turned upside down and hammered for the third time.

It should be observed that, in the two last operations, they do not increase the size of the trousse, they content themselves with heating the packet again. In the repetition of this operation each sheet has had one side turned towards the bottom of the trousse or packet, and one side turned towards the hammer and exposed immediately to the action of the fire.

This last side in consequence is better hammered than



MANUFACTURE OF SHEET IRON IN FRANCE, 1714.

the other; it is cleaner also and less charged with dross, which produces irregularity in the process of tinning. When they are making up a new trousse for furnace A, and the sheets are being prepared to be treated in the manner which we have described, the same workmen cut them to size.

For this purpose they make use of a pair of shears and a measure which determines the length of the sheet, each sheet is cut separately; when the sheets are cut and squared, an operation in which each double sheet is divided into two, the shears removing the bend, they take all the sheets and place them in piles on two thick flat bars of red-hot iron which are on the ground; they close these piles by placing one or two thick bars of flat iron above them. While the sheets of one trousse are being worked the packet which is to follow advances to the stage of being squared. But, in the heat which immediately precedes the squaring operation, they divide each packet into two and put between these two equal portions of unsquared sheets a certain quantity of squared sheets; they carry the whole to the big hammers, they hammer, and the square sheets in this way receive their last polish. After this operation the squared sheets go to the cellar and the unsquared sheets to the shears.

Of the sheets which are ready for the cellar some of the large imperfect sheets are put aside to be sold as sheet iron, the others are destined to be made into tin-plates. Before they are taken away, they are scrubbed with sandstone, then they go down to the cellar or cave where they are put in vats of sour water, that is to say, in a mixture of water and barley meal or rye, which is excited to acidulous fermentation by the action of great heat created and kept up by furnace F, where the smell is very strong and the heat most unpleasant.

This is done to clear the sheets, that is to say, to remove the scale of the forge which still covers them.

Perhaps it would be better partly to remove this scale from the sheets before they are put in the sour water, the water would act upon them better and with more certainty.

The sheets remain 3 times 24 hours in this water, where

they are turned and returned from time to time. Then they are taken out and given to the women, G, who rub them with sand and water, using also a cork and rag; this process is called "blanchir," and the women occupied in this process are known as "blanchisseuses."

After this scouring or blanchissement of the sheets they are put in water to protect them from the red rust, the fine rust which forms upon them falls off of itself. From the water they pass to the tin-house.

The tinning apparatus consists of a cauldron of cast iron, F, placed in the middle of a kind of table with plates of iron slightly inclined towards the cauldron and properly connected with it.

This cauldron is much deeper than the width of the sheet, which is always plunged in vertically and never on the surface, it contains 1500 to 2000 kilos of tin. In the masonry which supports the cauldron is fixed a stove like a baker's, of which the chimney is above the door, and which has no opening besides this door, which is on the opposite side to the tinman; this stove is heated with wood.

The tinman commences (should commence) his work at six in the morning, at ten o'clock on the previous night he should place his tin to melt in furnace F; when the tin is melted it should be left for six hours in a state of fusion, then the "secret" is introduced.

Nobody knows exactly what this mystery is, but it is supposed that it is copper, and this supposition is founded on the fact that the metal which is mixed should assist in the coating, and copper would have that quality because it is of a medium fusibility between iron and tin.

It is preferable to use that which has been melted in tin-coated copper vessels, and which already contains some portion of tin. You must take care not to have either too much or too little of this secret. The secret is in such small quantity in the tin that, in taking the coating off a large number of tin-plates, and making an assay of the tin, one cannot find any sensible addition, therefore there can be very little of it.

We can state with confidence that it is an alloy, but although there is very little of it, it must be neither too hot nor too cold.

These things cannot be described and are the affair of the workmen, the proper quantity can only be understood by practice.

The tin is melted under a coating of grease from 4 to 5 inches in thickness, because molten tin calcines readily when it is in fusion and exposed to the air, this precaution prevents such exposure, and perhaps even reduces some small portion of the tin which has already been calcined, this is a secret of which the manufacturers of tinned articles are very well aware. They know that the pretended scruff which forms on the surface of the molten tin, is in fact, "*chaux d'étain*," which can be reduced with tallow or other greasy matter.

This covering is of burnt grease, which is the cause of its black appearance.

From six o'clock in the morning, when the tin is at a proper heat (for when it is not hot enough it will not stick to the iron, and when it is too hot the coating is thin and unequal), they begin to work. They dip in the tin pot F, the sheets which have been taken out of the water, the workman throws them in altogether on their sides without troubling himself to separate them, and subsequently they are nearly all taken out together. This first operation having been performed on all the sheets the workman takes a part of them, which he plunges altogether into his molten tin, he turns them and re-turns them in every direction, dividing and sub-dividing his packet without taking them out of the cauldron; then he takes them one by one and dips them separately in a chamber separated by a plate of iron which forms a partition in the tin-pot, he takes them from the large cauldron to plunge them one by one in this division; having done this he puts them to drain on two little bars of iron placed parallel with each other and on their edges between little spikes of iron fixed perpendicularly; the sheets are placed upon the parallel bars of iron which support them and between the vertical bars which keep them upright.

A little girl, O, takes each sheet from out of this drainer, and if there are any little spots which have not taken the tin she scrapes them briskly with a kind of scraper and puts them on one side, from whence they are returned to the tinning.

As to those which are perfect they are distributed to girls, who with sawdust and moss rub them a long time to get the grease off. After that it is necessary to remove a kind of list which is formed on one side of the sheet when it is put in the drainer.

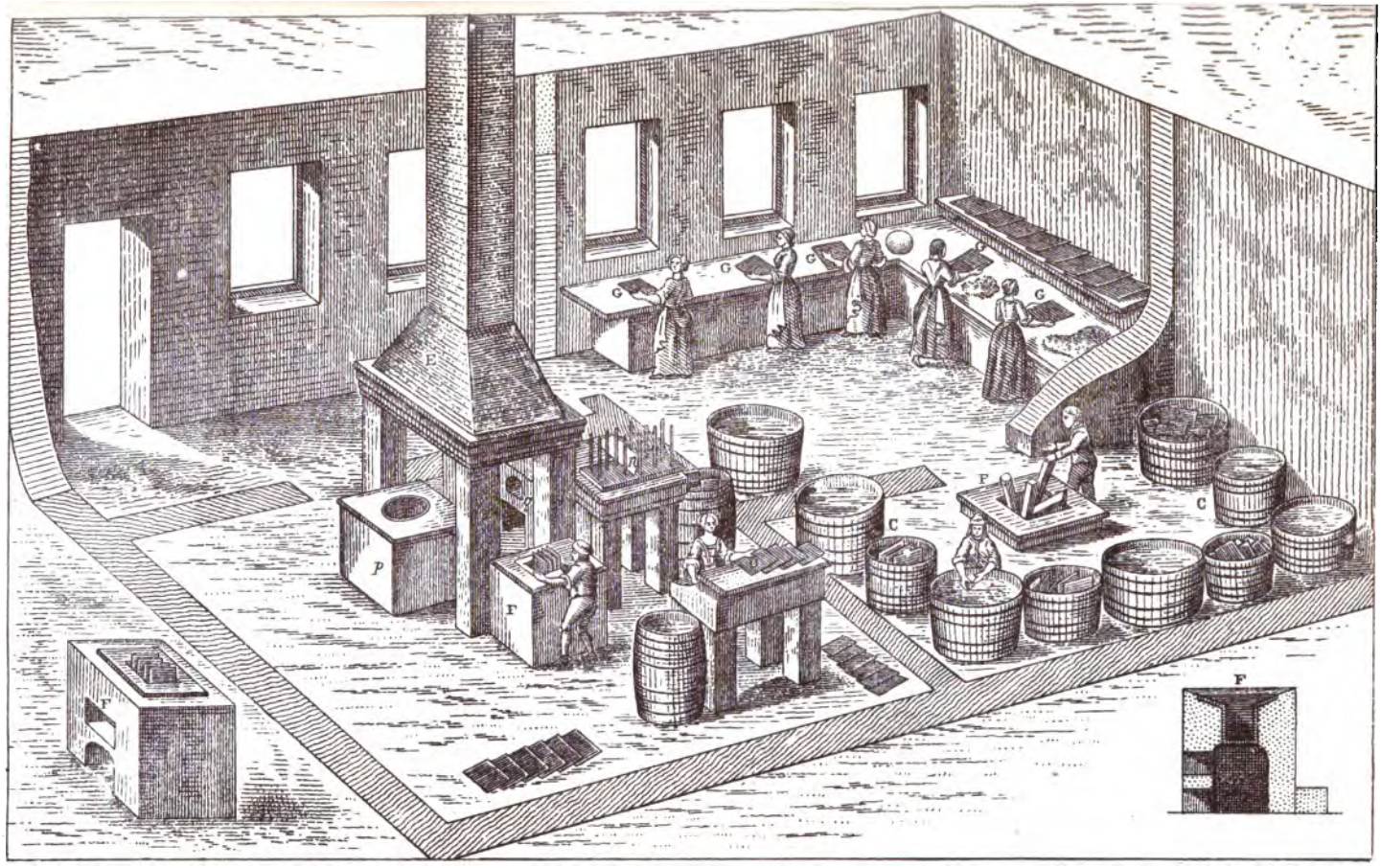
To accomplish this they dip the lower edge or border very carefully in molten tin in Q, specially taking care that the sheet is not dipped either too long or too short a time, otherwise the last coating in flowing might melt off the other and the sheet would remain black and imperfect.

After this immersion a workman rubs the plates briskly on both sides of the dipped place with moss, taking off the superfluous tin and the sheets are finished.

They make sheets of different widths, lengths, and thicknesses; the workmen say that the profit is immense.

The manufactory is at Mansvaux in Alsace.

P is a cauldron where they melt the grease; Q is a furnace of molten tin for tinning the plates.



MANUFACTURE OF TIN PLATES IN FRANCE, 1714.

CHAPTER VI.

EARLY MANUFACTURE IN GERMANY AND SWEDEN; TRANSLATED FROM 'RESEARCHES AND OBSERVATIONS CONCERNING MINES AND IRON WORKS, AND AS TO THE MANUFACTURE OF STEEL AND TIN-PLATES' MADE DURING TRAVELS IN GERMANY, SWEDEN, &c., BETWEEN THE YEARS 1757 AND 1769 BY M. JARS, PRINTED IN LYONS, 1744.

AT *Hülf Gottes Irgand* there is a hæmatite iron ore mine, at a distance of 400 paces from which is a tin mine, and there are some abandoned tin mines in the immediate neighbourhood.

This iron mine furnishes large quantities of ore, which is sent to thirteen iron works in Saxony and Bohemia, in most of which works tin-plates are manufactured.

Hülf Gottes Irgand is distant three miles from Platten; there is a tin-plate works at Johann-Georgenstadt, a town in the high mountains of Saxony, situated at a distance of seven miles from the iron mine.

The iron ore is purchased from the mine; the carriage to the works costs less in the winter than in the summer because of the convenience of snow and sledges.

The following is the process adopted for the manufacture of tin-plates at a works between *Heinrichsgrün* and *Graslitz*, in Bohemia, and the same processes are in use at *Hülf Gottes Irgand;* the iron ore which is necessary, comes from the latter place.

The iron when taken from the refinery is beaten into a square form of about $2\frac{7}{8}$ inches, then carried to the tilt hammer and cut into pieces of such a size that one piece shall furnish two sheets of iron.

The pieces are then warmed in a forge where there are

two simple wooden bellows moved by a water wheel, and where charcoal is employed to heat them.

When the pieces are sufficiently heated they are flattened out under a hammer, then they are bent double in such a manner that each piece forms two sheets, one upon the other, of about $9\frac{3}{8}$ and $5\frac{3}{8}$ in.

When sufficient sheets have been thus prepared they are placed in water with which they mix a small quantity of clay and charcoal-dust, so that the sheets may not stick together when hammered.

When they have been thus plastered, they are placed upon the hearth of the forge piled upon iron bars, so arranged that the draught may pass up from beneath them. 200 of these pieces, which will produce 400 sheets (for each one is double), are placed at the same time upon the grate.

Care is taken to place them upright, in order that they may heat more readily, the wind (blast) passing from underneath, without acting directly upon the sheets, renders them red hot in 30 to 45 minutes at the utmost.

When they consider the sheets to be sufficiently heated, they take one-fourth of them with a pair of tongs (50 pieces or 100 sheets), and place this bundle, which is about $8\frac{6}{8}$ in. thick, under a hammer, weighing about 550 lbs. when new.

This bundle is reduced by the first hammering to a thickness of $4\frac{3}{8}$ in.

The four bundles are thus each in their turn beaten and returned to the fire as soon as they have been hammered, but they are not again placed upon the iron bars which were supporting them at first.

The second time these bundles are forged, they are reduced to $3\frac{1}{8}$ in., and at this point the outside sheets are shifted to the middle of the bundle.

These bundles are next heated and beaten for the third time, the narrow sheets are divided, and they are then heated and hammered for the fourth time.

Then they place in the bundle sheets which have been cut by the shears to the exact dimensions which are required.

They are not again heated, but are taken in this state to the hammer, which is used softly; the sheets are only beaten this last time in order to clear them from the dust which is between them, and the other sheets are placed with them in order that they may be made even and smooth after the creases caused by the shears.

Afterwards each sheet is cut to the proper size, and by the same workmen as were engaged in heating and hammering it.

In order to save time they generally place some pieces in the fire, as described in the first operation, in order that they may be heating while the workmen are engaged in shearing the plates.

The wheel (cam-shaft) revolves nineteen times during the minute, and thus the hammer gives seventy-six blows per minute, since there are four skids or arms to the lever (cam-ring).

The cam-ring is 36½ inches diameter, the skid or arm projects 12⅞, the helve is 48 inches long, it is in the middle that it receives the arm when the hammer is at work.

To clear the sheets of hammered iron and to prepare them for coating they have an arched stove, in the middle of which they keep a coal fire constantly burning.

All around are casks full of water which has been made sour by the addition of ryemeal.

This flour is used just as it comes from the mill, it is neither bolted nor sifted, they place 1200 cubic inches of flour in each cask; the water very soon becomes sour from the fermentation occasioned by the heat, which is so great that, when the door is opened, it seems to be impossible that anybody could enter or endure it.

To clear or pickle the sheets of hammered iron when they come from the forge, they are put into one of the casks in which the sour water is old and strong; it is made stronger from time to time by the addition of a little more meal, each lie serves eight days for the strong and eight days for the weak pickle, after that it is thrown away.

They place 300 sheets at one time in these casks, vertically

or upright; they remain for twenty-four hours, at the end of that time the sheets are dipped in fresh sour water, that is to say, water in which fresh meal has been put.

After that they are taken out and placed in a very old lie, into which is thrown every fortnight a hatful of meal, the sheets remain altogether three times twenty-four hours in the stove.

When taken from the stove they are placed in casks full of pure water, where they remain until they are wanted for cleaning, this is done with sand and water, and all the black spots are removed.

This work is very quickly done, they are then put again into water to protect them from rust, where they remain until they are required for tinning.

The tinning pot in which these sheets are tinned is made of cast iron; it is 19½ inches deep; it contains 11 cwts. of 140 lbs. Prague; it is never left empty, for when the tinning of the sheets is completed new tin is added.

Then water and tallow are placed on the surface of the tin, and all is left to cool till the day when the pot is again required for tinning.

Then they light a fire under the tin pot sixteen or seventeen hours before the tin is required for use, in order that the metal may become clear; when it is quite liquid the tin is taken with a ladle, and poured from a great height back into the tin-pot several times, the metal is then skimmed and the same process repeated till the tin is perfectly clear.

Then, to test the heat or temper of the tin-pot, a pickled sheet of iron is dipped into the liquid metal: if the coating is yellow the tin is too hot; if, on the contrary, it has a silvery white appearance, the tin is considered to be at the proper temperature.

There are very few tin-plates which have not yellow spots, and it is almost impossible to avoid them without putting too much tin on the sheets.

M. Jars, after his experiments made in 1768 at the works of M. Sauvage in the Nivernois, France, recommended the

use of great heat in order to produce a smooth and economical coating.

To remove the yellow spots he took the worst of them, and had them boiled for two or three minutes in lees of wine, this was perfectly successful, and they came out of a fine white silver colour, and without the least stain.

As to the copper which is mixed with the tin, no one can say the exact quantity, it depends equally upon the quality of the tin and of the iron.

If too much copper is put in the sheets do not look fine, if on the contrary there is not enough, the sheets take too much tin, as a rule they add 2 lbs. of copper to a hundredweight or 140 lbs. of tin.

When the tin is sufficiently hot they put in a rather thick sheet of iron as long and as deep as the pot, this sheet is placed vertically, and serves to separate the large bath, where the plates are first dipped, from a small division of $1\frac{5}{8}$ inches wide, where they are dipped again.

When the tin is quite liquid they add a little tallow, which melts immediately, and then some pure water, which causes it to swell and foam; they then bring 100 iron sheets quite wet from the water, they put them over the foam, and by means of a pair of tongs they are gradually placed quite flat under the tin and at the bottom of the tin-plate.

They then bring 100 more sheets, which they place in the same manner; they are left there for about fifteen minutes; they move the sheets about with their tools, and with a ladle they skim off the tallow and water from the surface of the bath, placing it in an earthenware pan which is near.

A man then dips his tongs into the water, and removes the sheets one by one; he places them vertically upon two bars of iron on which are two rows of spikes, which serve to support these sheets, there are partitions in which to place a few of them.

Another workman takes these same sheets one by one, and dips them in the division of $1\frac{5}{8}$, separated from the larger bath by a sheet of iron as explained.

He plunges and immediately removes the sheet which he is holding, and places it vertically over a grate of iron, made with long spikes and similar in shape to the former one, but the spikes are longer.

This grate will hold fourteen sheets when placed in it, without touching one another, as they are separated by the spikes. It is in this way that the sheets are drained.

When fourteen sheets have been placed in the grate, a little boy takes out one which another boy replaces with a freshly dipped sheet; the first of these sheets is given to a woman who clears off the grease with a piece of stuff which she holds in each hand, rubbing it afterwards in sawdust, all this work is done very quickly as will be afterwards apparent from the quantity which is tinned.

When 100 sheets have been taken out of the pot, they put in all the tin which has dropped from the sheets, and then they cover it with the tallow which was previously removed, then they pour in fresh water, and again a considerable swelling takes place.

Then they bring 100 fresh sheets wet from the stove, which are seized all together with a strong pair of tongs, and plunged into the tin bath in such a manner that they are made to go to the bottom of the pot and beneath the 100 sheets which remain from the first filling.

They stir with a piece of wood, and again remove the tallow and the water which is poured into an earthenware pan which is near; however, they take care to leave a little tallow on the surface of the bath, and the sheets are then taken out one by one, as previously described.

When the sheets of tin-plate have been cleaned with sawdust close to the pot, they are carried into a room near to the stove where they are kept warm, then a woman rubs them in a box with oatmeal, and another woman rubs them again with oatmeal; these women have each an old piece of stuff or linen in their hands, then the plates are passed on to a third woman who completes the cleaning operation.

As the lower edge of these tin-plates is thicker than every

other part, and full of drops from the drainage of the tin, they have a small iron pot of a prismatic form, shaped with two inclined planes of about 4 inches deep and 4 inches wide at the top, but much narrower at the bottom, and long enough for the sheets which are to enter.

There is in this little pot some of the same tin as has been used for tinning rather more than an inch in depth, but there is no tallow on the surface; underneath is a fire to keep the tin hot, they dip in this the *lower* edge of the tin-plates in order to remove the surplus tin.

It is a little boy who dips them one after the other into this pot, and they are then taken by a man who rubs the edge, which has just been dipped, with moss, and this is the last preparation which is given to tin-plates.

Afterwards thirty or forty of these sheets are placed together and beaten above and below with a mallet on a large block of wood, in order to pack them closer; they are afterwards bent a little in the middle, so that they show better in the casks.

The sheets which have defects are put aside and sold at a lower rate than the others.

The tin-plates made are of two sizes, $11\frac{7}{8} \times 9$ and $18\frac{3}{8} \times 11\frac{3}{8}$.

They use $1\frac{1}{10}$ lb. of tallow, and 16 lbs. tin for 300 of the small sheets and double for the larger sheets.

The work (of tinning), which has been described, is performed twice a week, on Thursdays and Saturdays.

They tin 1800 sheets in five hours, they are rubbed and cleaned in the same time.

When they are completely finished they are placed in small casks, each cask containing 300 sheets and weighing 140 lbs. Prague.

The cask sells for 60 francs on the spot. About 600 to 800 casks are manufactured yearly; they are exported to several countries.

The barrels containing the large sheets are sold for double the price, 120 francs.

The master who has superintended the work receives 27 sous 6 deniers for the manufacture of 300 small sheets;

and out of that he pays all the workmen, but the materials which are necessary are provided for him.

The only differences between this tin-plate works and those of Johann-Georgen-Stadt, are, that after putting all the sheets into the tin bath for a few minutes, they are taken out and returned altogether to the bath when they are cold.

They use rather more tin in Bohemia. They work up to 21½ lbs. for 300 sheets, but the sheets are larger, and they pass them through twice; they make $12\frac{3}{8} \times 9\frac{5}{8}$.

Tin-plate Works in Sweden.

At Joahnessors, about five miles from Forsmark, there is a tin-plate and a nail manufactory.

They do not employ rolls to make sheets suitable for tin-plates; they have tried them, but from prejudice, or some other reason, they consider the method of forging them out under the hammer to be most advantageous.

These works were established about 1739; they brought from Saxony and Bohemia workmen who understood the manufacture; in 1767 there were seven of them who superintended all the work.

The iron is brought from the forge of Forsmark in long square bars, the workmen divide them into as many pieces as they require to produce sheets of such or such a size, they manage this by marking off each division with chalk, the bars are then placed in a reverberatory furnace which is continually burning to make them red hot, then they are taken out and "presented" to the shears, which is driven by water power, and which divides them to the size desired.

They have the same sort of heavy hammer at all the works in Sweden, under which all these pieces are beaten out one by one; after having been heated in the same reverberatory furnace, they are enlarged by hammering to double their original size, and then they are bent one upon the other.

During the process of forging out the pieces to size, the number of sheets is increased at each beating, so that, having

started with one, they finish with ninety-six, which they hammer together; however, they take care not to overheat the sheets because they would then run the risk of being welded together.

In order to avoid this inconvenience when the bundle is taken out of the furnace and before it goes to the hammer, they take care to place it (the bundle) on the ground, the workman holds it vertically with a pair of tongs, then a little water is thrown all over it and coal dust after that, which introduces itself between the sheets and effectually prevents the welding.

They are careful to remove the upper and under sheets, which are placed in the middle of the bundle; they also do the same with the inside sheets after shearing.

After every beating, they are obliged to cut a great deal off the sides.

They manufacture sheets of several sizes, which are heated eight times in the furnace and subsequently placed eight times under the hammer before they are completely finished.

It is possible in one week to forge with one hammer $12\frac{1}{2}$ schiffund of iron and to hammer out 4320 sheets, which weigh no more than 8 schiffund, the shreds (shearings) which result are about 3 schiffund, so that, on this quantity, there is $1\frac{1}{2}$ schiffund of loss.

In 1766 they only produced 190 schiffund at Joahnessors, although the proprietor had liberty to make up to 300 schiffund.

When the sheets have been finished under the hammer, and after being cut to size in the hand shears, they are carried away to the stove for pickling, which is done in the same way as in Bohemia.

The tin-pot is of cast iron, and of the same dimensions at the top and bottom of the pot, the inside measure is $18\frac{1}{8}$ inches long $\times$ 16 inches wide and 16 inches deep: it is placed over a furnace fixed in masonry.

The surface is constructed with four inclined planes (one on each side), and the whole are covered with plates of iron

exactly fitted to the tin pot, so that any surplus tin running over the said planes passes back again to the tin-pot.

This cauldron (the pot) is generally partly full of water, because when they have finished tinning, they add fresh tin and tallow, and cover them up with water, and it all remains cold till the day when it (the pot) is again required for use.

When they start again, a fire is lighted under the pot, fifteen or sixteen hours beforehand, as in Bohemia.

English tin is employed, to which they add about 2 lbs. of copper to every 17 or 18 lisgund of tin.

CHAPTER VII.

A DESCRIPTIVE ACCOUNT OF THE SEVERAL PROCESSES WHICH ARE USUALLY PURSUED IN THE MANUFACTURE OF THE ARTICLE KNOWN IN COMMERCE BY THE NAME OF TIN PLATE, BY SAMUEL PARKES, ESQ., IN A LETTER TO B. NAYLOR, ESQ., FEBRUARY 20, 1818.

As the processes in this manufacture are more numerous and complicated than is generally imagined, it may be advisable to preface the account with an enumeration of some of those properties of tin which will be most likely to explain the rationale of the principal operations.

Tin has a great affinity for several of the other metals, particularly for zinc, mercury, copper, antimony, lead, and iron, and owing to these affinities, its employment in the arts is very considerable.

Tin with zinc forms a metal of close grain, very useful for many purposes, especially for the formation of pewter. The zinc is found to impart great hardness to the tin, without lessening its ductility.

The combination of mercury and tin, in which the tin is dissolved by the mercury into a very soft amalgam, is largely employed, as is well known, in silvering the backs of mirrors, and for other purposes in the arts. An amalgam of tin of greater consistence was formerly in use in the museums of Paris for closing the mouths of glass bottles containing sundry curious and valuable preparations.

Copper is also alloyed with tin for various purposes of manufacture. This metallic mixture is employed in working what are called bronze statues; for casting bells, and pieces of artillery, and also for the fabrication of medals and medallions. In some of these cases the tin is mixed with

copper, on account of its property of rendering the copper more fusible, and this was probably the reason why the Ancient Romans used that metal in the greater part of their brass coinage. It is owing to the affinity of tin for copper, that vessels of capacity, made with the latter metal, for culinary and other purposes, are so readily covered with a coating of tin, to preserve them from the action of substances which would not fail to erode copper if unprotected by some such covering. The affinity of tin for copper is farther exemplified by the process of whitening pins, which is effected by boiling the pins with granulated tin, in a lie made with alum and tartar.

A useful alloy is likewise formed by the mixture of tin and antimony. This metallic compound is very white, extremely hard, and will bear a very fine polish. On these accounts it is employed in making specula for telescopes, and also for the manufacture of rolled plates to engrave music upon.

The next metal which I have mentioned as uniting readily with tin is lead. This metal will combine with tin in any proportion, and in most proportions the lead acquires a greater degree of fusibility by its union with the tin. It is this alloy which forms plumbers' solder, but that compound is prepared with different proportions of tin, according to the purpose for which it is intended. The article called tin foil, used for lining tea-caddies, for coating electrical jars, and for other purposes, is also made from a mixture of these two metals.

But what is more relevant to the subject of this paper, is the chemical affinity which subsists between tin and iron. One of the strongest proofs of this affinity is derived from the circumstances that even cast iron may be tinned in the same manner as wrought iron.

Of late years, cast iron saucepans, and pots of a large size, are *permanently* tinned on their inner surfaces, to prevent the liquors which are boiled in them from acquiring any stain by a partial dissolution of the iron. Many other articles, such as bridle bits, common stirrups, small nails, &c., are now

made much cheaper than formerly, by first fabricating them in cast iron, and then covering them with a thin coat of tin, by the immersion of them in a hot mass of that fluid metal.

That these effects are owing to chemical affinity cannot be doubted, when it is considered that in all these cases the pores of the iron are in some degree actually penetrated by the tin.

In the manufacture of tin plate, which I am now about to describe, a similar effect is produced, and also by the same means. Plates of iron properly prepared are immersed in a large mass of melted tin, which is kept hot by a fire constantly burning underneath it, the consequence of which is, that the tin in some measure penetrates the iron, and this attaches other tin to it, so that the whole surface of the iron acquires, by this means, a complete covering of that metal.

As no accurate account has ever yet been given of the various processes by which this is effected, the following outline may probably be acceptable to the members of your very respectable Society.

English bar iron of the finest quality, called tin iron, and which is generally prepared with charcoal instead of mineral coke, and made with the greatest care, for this particular purpose, is first cut to the necessary length, and then rolled at the mill, by a process which is peculiar to this manufacture, into plates of the requisite thinness, and of such form as is suitable for the business. These plates are then cut by hand shears to the sizes suitable to the different markets.

And as the shearer shears the plates, he piles them in heaps, occasionally putting one plate cross-wise to keep each box separate. Two hundred and twenty-five plates are called a box, but they are not put into boxes of wood in this stage of the operation. The iron plates now go into the hands of the scaler, who takes them from the shear-house, and bends each of them singly across the middle, into this form Λ, preparatory to their being cleaned for tinning, and for the conveniency of putting them into the scaling furnace, as will be more fully explained hereafter.

This furnace, or oven, is heated by flame thrown into it from a fireplace of peculiar construction, and it is this flame that scales the plates, which are put into the oven in rows, and arranged three in each row, until the oven is full. It will be obvious that if they lay flat on the floor of the oven, the flame could play only on one side of each plate, whereas, by being bent in the form already described, the flame can operate equally on both sides. It may here be remarked that the form of all tin plates, one sort excepted, is that of a parallelogram, and that if a piece of stiff paper, or pasteboard, 13¾ inches long, and 10 inches wide, be bent in the centre at an angle of about sixty degrees and then put to stand on the two ends, we shall have the form of a plate properly bent for the scaling oven.

The operation of cleansing, as it is called, and which is preparatory to the process of scaling, is commenced by steeping the plates, for the space of four or five minutes, in a mixture of muriatic acid and water, in the proportion of four pounds of acid to three gallons of water. This quantity of the diluted acid will generally be sufficient for eighteen hundred plates, or eight boxes of 225 plates each.

When the plates have been steeped for the time prescribed, they are taken out of the liquor, and placed upon the floor, three in a row, and then, by means of an iron rod put under them, they are conveyed to a furnace heated red hot, where they remain until the heat takes off the scale, the removal of which was the object in submitting them to that high temperature.

When this is effected, the plates are taken to a floor where they are suffered to cool; they are then straightened and beaten smooth upon a cast-iron block. The workman knows by the appearance of the plates during this operation, whether they have been well scaled, for if they have, that is, if the rust or oxide which was attached to the iron has been properly removed, they will appear mottled blue and white, something like marbled paper. The operation we have been describing is called scaling.

As it is impossible the plates can go through this process

without being in some measure warped, or otherwise disfigured, they are now rolled a second time, between a pair of cast-iron rollers, properly hardened and finely polished. This operation makes both sides of the plates perfectly smooth, and imparts a sort of polish to their surfaces. These rollers are each about 17 inches long, and 12 or 13 inches in diameter, but I am inclined to think that if the diameter was greater, they would make the plates flatter, and do the work better in every respect.

The technical name of this apparatus is "rolls," not rollers. All the rolls which are employed in rolling plates, either hot or cold, in this manufactory, are hard rolls, and there is as much difference between a pair of hard cast-iron rolls, and a pair of soft rolls, although they may both be run out of the same pot of metal, as there is between iron and steel. The workmen informed me that the difference is entirely occasioned by the manner of casting them, the soft rolls being cast in sand, whereas the hard rolls are formed by pouring the metal into a thick cast-iron box, and that the metal, by coming in contact with the cold box, is sufficiently chilled to render the whole face of the roll entirely hard. The difference in the temper of these two kinds of rolls is so great, that when they are put into the lathe to be turned perfectly true, the turnings from the one will be $\frac{1}{8}$th of an inch in thickness, whilst the turnings which come from the other are not larger than very fine needles. The temper of cast iron thus varying according to the nature of the mould into which it is poured, is a circumstance that appears to me to be deserving of attention in the manufacture of a variety of other utensils employed in the arts.

The art of making good hard rolls appears to be very imperfectly understood, because the difficulty of producing them is very great. Not one in three can be called thoroughly good. For if they are not sufficiently hardened on the surface they will not wear, whereas if they are made hard throughout, or struck hard to the centre, as the workmen call it, they will generally crack across the middle and become useless. This fault is quite independent of air

bubbles or flaws, which are always discoverable in turning by the lathe.

These rollers are used without heat, but they are screwed down very close one upon the other, only leaving bare room for the plates to pass, that the utmost attainable degree of pressure may be given to them. This last operation is called cold rolling.

When the plates have undergone this process, they are put one by one into troughs filled with a liquid preparation called the lees.

This is merely water in which bran has been steeped for nine or ten days, until it has acquired a sufficient acidity for the purpose. The design of putting the plates into the troughs singly, is, that there may be more certainty of the liquor getting between them, and both the sides of every plate being soaked alike in the lees. In this liquor they remain for ten or twelve hours standing on the edges, but they are turned, or inverted, once during that time. This operation is called working in the lees.

The next operation is that of steeping in a mixture of sulphuric acid and water, in proportions which vary according to the judgment of the workmen.

The trough in which this operation is conducted is made with thick lead, and the interior is divided by partitions of lead. Each of these divisions is by the workmen called a hole, and each of them will contain about one box of plates. In the diluted sulphuric acid which is in the different compartments of this vessel, the plates are agitated for about an hour, or until they have become perfectly bright, and entirely free from the black spots which are always upon them when they are first immersed in it.

Some nicety, however, is required in this operation, for if they remain too long in the acid they will become stained or blistered by it, as the workmen term it; but practice enables a careful operator to judge of the time when they ought to be removed. This, however, is one of the most difficult parts of the business, as few men like to work in it; though I understand that a good pickler is highly valued by

his employers, and obtains great wages. It is necessary to notify that this and the former process with the acidulated water are both hastened by giving to those menstrua an increase of temperature, and this is effected by means of heated flues which run under each trough. Little additional heat is necessary in summer, however, as 90° or 100° of Fahrenheit is a temperature sufficiently high for either of these operations.

When the plates come out of the pickle, they are put into pure water, and scoured in it with hemp and sand, to remove any remaining oxide or rust of iron that may be still attached to them, for wherever there is a particle of rust, or even dust upon them, there the tin will not fix; and they are then put into fresh water to be there preserved for the process of tinning. The design of putting the plates into pure water, after they come out of the sours, is to prevent their becoming again oxidated, for it has been found that after these operations they will acquire no rust, although they should be kept twelve months immersed in water.

It will be perceived that all these processes are nothing more than preparatory measures for the operation which is to succeed, viz. that of tinning.

For this purpose an iron pot is nearly filled with a mixture of block and grain tin, in a melted state, and a quantity of tallow or grease, sufficient, when melted, to cover the fluid metal to the thickness of 4 inches, is put to it. However, as some gentlemen may not be acquainted with the difference between block and grain tin, it may be remarked, before we proceed, that the metal known in commerce by the name of block tin, is prepared either from the mineral called tin stone, or the one known in Cornwall by the name of tin pyrites, whilst the article called grain tin is smelted from an ore which is found in grains called stream tin ore, under beds of alluvial soil, in low situations, whither, in the course of ages, it has been washed from the hills by a succession of torrents of rain. The former, which is produced in the greatest abundance, is always contaminated with a portion of iron, sulphur, and other injurious substances, and is therefore only

employed for common purposes, while the grain tin, which is nearly free from every impurity, and is usually from twenty to thirty shillings per hundredweight dearer, is used in the processes of dyeing, and in all other cases where pure tin is required. I am also desirous of remarking, that, in my opinion, it would be more profitable to the proprietor of a tin-plate works, if he were to use grain tin alone, or grain tin mixed with that kind which is known by the name of refined tin, because these kinds not only contain less dross, but they melt, as I know by my own experience, into a more fluid metal; and, consequently, more would run off the plates in the operation of tinning, and less tin would be consumed. At present these manufacturers use the block and grain tin in equal proportions.

When the tin pot has been charged in the way above mentioned, the metal is heated from a fire placed underneath it, and by flues which go round the pot, until it is as hot as it can be made without actually inflaming the grease which swims upon the surface. The use of grease is to preserve the tin from the action of the atmosphere, and, consequently, to prevent it from oxidating. By melting a little tin or lead in an iron ladle, and when the dross is skimmed off, putting a morsel of tallow upon the metallic fluid, the effect of the tallow in cleansing the face of the metal will be evident. The workmen also say that it increases the affinity of the iron for the tin, or, as they express it, that it makes the iron plates take the tin better.

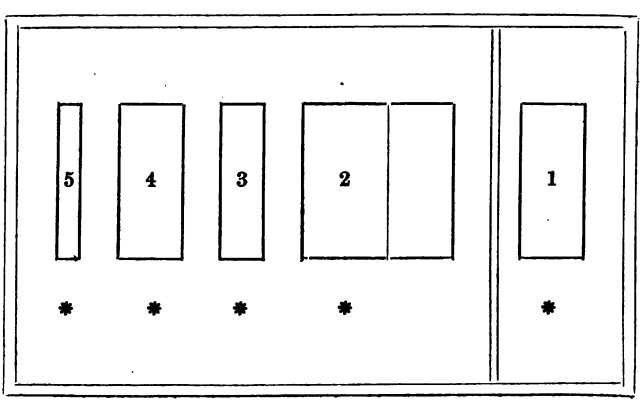
It is curious that burnt grease, or any kind of empyreumatic fat, effects this purpose better than pure fresh tallow.

Another pot, which is fixed by the side of the tin pot is filled with grease only, and in this the prepared plates are immersed one by one before they are treated with the tin; and when the pot is filled with them, they are suffered to remain in it so long as the superintendent thinks necessary. If they remain in the grease an hour they are found to tin better than when a shorter time is allowed them.

From this pot they are removed, with the grease still adhering to them, into the pot just before spoken of, which contains the body of melted tin, and in this they are placed in a vertical position. Three hundred and thirty-eight or three hundred and forty plates are usually put into this pot at once; and, for the sake of their being thoroughly tinned, they usually remain in it one hour and a half, but occasionally more time is required to complete this operation.

When the plates have been a sufficient time immersed in the melted tin, they are taken out and placed upon an iron grating that the superfluous metal may drain from them; but, notwithstanding this precaution, when they become cold there is always more metal found adhering to them than is necessary; and this is taken off by a subsequent process, called washing. As this process is rather complicated, it will be necessary to describe it with some minuteness.

In the first place, the wash man prepares an iron pot which he nearly fills with the best grain tin in a melted state, another pot of clean melted tallow, or lard, free from salt, a third pot with nothing within it but a grating to receive the plates, and a fourth, called the listing pot, with a little melted tin in it, about enough to cover the bottom to the depth of a quarter of an inch. The whole will however, be better understood by referring to the following drawing,



which exhibits the several vessels in the order in which they stand in the manufactory, all supported by substantial brickwork.

The building in which the pots are fixed is called the stove. The plates are worked from the right to the left of the stove, as will be evident by attending to the uses of the separate pots.

No. 1 Represents the tin pot.
No. 2 „ the wash pot with the parting within it.
No. 3 „ the grease pot.
No. 4 „ the pan, containing a grating at the bottom.
No. 5 „ the list pot.

The drawing represents the surface of the pots. The asterisks show the places where the workmen stand, and also mark those pots which have heated flues under them. No. 4 has no fire under it.

The parting in the wash-pot No. 2 is a late improvement. The design of it is to keep the dross of the tin from lodging in that part of the vessel where the last dip is given to the plates. By using common tin in the first process of tinning, much oxide, or dross, adheres to the surface of the plates, and this runs off in the wash-pot, and comes to the face of the new metal, but this parting enables the operator to prevent it from spreading over the whole surface of the pot.

Were it not for this parting, the wash man must skim the oxide off the fluid metal every time he puts plates into it. The pots of which I have given a sketch being all in a state of fitness, the wash man commences his part of what remains of the business by putting the plates which have undergone the various operations hitherto described into the vessels of grain tin, called the wash-pot. The heat of this large body of melted metal soon melts all the loose tin on the surface of these plates, and so deteriorates the quality of the whole mass, that it is usual when 60 or 70 boxes have been washed in the grain tin, to take out the quantity of a block, say 3 cwt., and replenish the wash-pot with a fresh block of pure grain tin. These vessels generally hold three blocks

each, or about half a ton weight of metal. That which is taken out of the wash-pot when it is replenished with pure metal is given to the tinman to put into his pot.

When the plates are taken out of the wash-pot, they are carefully brushed on each side with a brush of hemp of a peculiar kind, and made expressly for the purpose. As this part of the business requires considerable adroitness and expedition, it may be worth while to explain it a little more in detail.

The wash man first takes a few plates out of the wash-pot, and lays them together before him on the stove; he then takes one plate up with a pair of tongs, which he holds in his left hand, and with a brush held in his right hand brushes one side of the plate, he then turns it and brushes the other side, and immediately dips it once more into the hot fluid metal in the wash-pot, and without letting it out of the tongs, instantly withdraws it again, and plunges it into the grease-pot (marked No. 3) adjoining to the wash-pot from whence he had just taken it.

A person who has not seen the operation can form but a very inadequate idea of the adroitness with which this is performed; practice, however, gives the workman so much expedition, that he is enabled to make good wages, although he obtains only threepence for the brushing and metallic washing of 225 plates. I am informed that an expert workman, if he makes the best of his time, will wash twenty-five boxes, consisting of 5625 plates, in twelve hours, notwithstanding every plate must be brushed on both sides, and dipped twice into the pot of melted tin.

Why the plates should be dipped twice during this part of their manufacture may perhaps require some explanation. It must be recollected that they are brushed quite hot, and before the tin is set, therefore if they had not the last dip the marks of the brush would be visible. Moreover, the brush takes the greatest part of the tin off them, so that if they were removed to the grease-pot without being redipped, the grease would take off what remained.

The only use of the grease-pot is to take off any superfluous

metal that may be upon the plates; but this is an operation that requires great attention, because, as the plate is immersed in the grease while the tin is in a melting, or at least in a soft, state upon it, a part must run off, and the remainder become less and less while the plate continues in it, therefore if these plates should ever be left in the melted tallow longer than is absolutely necessary, they will doubtless require to be dipped a third time in the tin. On the other hand, if the plates were to be finished without passing through the grease, they would retain too much of the tin, which would be a loss to the manufacturer, and besides, the whole of the tin would appear to be in waves upon the iron. It is also equally necessary to attend to the temperature of the melted tallow, which must be colder or hotter in proportion as the plates are thicker or thinner, for if, when the tallow is of a proper temperature for a thin plate, a thick one was to be put into it, it would come out not of the colour of tin, as it ought to be, but as yellow as gold. The reason of this is evident. The thick plate contains more heat than a thin one, and consequently requires the tallow to be at a lower temperature. On the contrary, if a parcel of thin plates were to be worked in a pot of tallow which had been prepared for thick plates, such a pot would not be hot enough to effect the intended purpose.

It is a common observation that in most of our manufactures, and in all chemical speculations, theory and practice are generally at variance, but there are few manufactures, perhaps, where there are so many minutiæ which would escape the notice of a casual observer, and yet they require to be carefully attended to in order to produce a good result, as in that which we have now been describing; and should the perusal of this paper occasion but one individual to pause who was about to enter into a new concern with which he was only partially acquainted, I shall have written to a good purpose.

But to return to the process. When the plates are sufficiently brushed, they are again immersed one by one in the pot of melted tin, as has already been remarked, and

immediately from this they are put into the pot of tallow above mentioned. This pot has pins fixed within it, in such a manner as to prevent the plates from touching each other; and this part of the process is conducted in the following manner.

When the wash man has passed five of the plates through the melted tin, and from thence into the pot of tallow above mentioned, a boy takes out one of them and puts it into the empty pot to cool, and the wash man puts in the sixth plate. The boy then takes out a second plate, and lays it to cool likewise, when the man puts in his seventh, and so they go on, in this regular manner, until the whole of the parcel is finished.

In consequence of the plates being immersed in the melted tin in a vertical position, there is always, when they have become cold, a wire of tin on the lower edge of every plate, which is necessary to be removed, and this is done in the following manner.

A boy, called the list boy, takes the plates when they are cool enough to handle, and puts the lower edge of each, one by one, into the list pot, which is the vessel that was before described as containing a very small quantity of melted tin, and the same as that which I have marked No. 5. When the wire of tin is melted by this last immersion, the boy takes out the plate, and gives it a smart blow with a thin stick, which disengages the wire of superfluous metal, and this falling off, leaves only a faint stripe in the place where it was attached. This mark may be discovered on every tin plate which is exposed for sale—the workmen in the manufactory call it the list.

Nothing now remains but to cleanse the plates from the tallow. This is done by means of bran, and as they are cleansed they are put into strong wooden boxes or boxes of sheet iron, made exactly to fit them; and this completes the whole business. Each box contains a determinate number of plates, and the following table will show the different sizes of tin plate which are made in Great Britain, and the marks by which each kind is known in commerce.

Names.	Sizes.	No. in a Box.	Weight of each Box.	Marks put on the Boxes.
	inches.		c. q. lbs.	
Common No. 1	13¾ × 10	225	1 0 0	CI.
„ „ 2	13¼ × 9¾	„	3 21	CII.
„ „ 3	12¾ × 9½	„	3 16	CIII.
Cross „ 1	13¾ × 10	„	1 1 0	XI.
Two Cross „ 1	„ „	„	1 1 21	XXI.
Three „ „ 1	„ „	„	1 2 14	XXXI.
Four „ „ 1	„ „	„	1 3 7	XXXXI.
Common Doubles	16¾ × 12½	100	3 21	CD.
Cross Doubles	„ „	„	1 0 14	XD.
Two Cross Doubles . . .	„ „	„	1 1 7	XXD.
Three „ „ . . .	„ „	„	1 2 0	XXXD.
Four „ „ . . .	„ „	„	1 2 21	XXXXD.
Common Small Doubles . .	15 × 11	200	1 2 0	CSD.
Cross „ „ . . .	„ „	„	1 2 21	XSD.
Two Cross „ „ . . .	„ „	„	1 3 14	XXSD.
Three „ „ „ . . .	„ „	„	2 0 7	XXXSD.
Four „ „ „ . . .	„ „	„	2 1 0	XXXXSD.
Wasters Common No. 1 . .	13¾ × 10	225	1 0 0	WCI.
„ Cross „ . .	13¾ × 10	..	1 1 0	WXI.

A List of the Current Wholesale Prices of Tin-plate in September, 1817, in London.

Sorts.	Weight.	Prices per Box.	No. in each Box.
	lbs.	s.	
C No. 1 . . .	112 to 115	41	225
C „ 2 . . .	103 „ 106	39	
C „ 3 . . .	98 „ 101	37	
X „ 1 . . .	140 „ 142	49	
XX „ 1 . . .	160 „ 163	55	
XXX „ 1 . . .	182 „ 185	61	
CD	98 „ 103	37	100
XD	126 „ 129	45	
XXD	147 „ 150	51	
XXXD	168 „ 171	57	
CSD	167 „ 170	63	200
XSD	188 „ 191	69	
XXSD	209 „ 212	75	
Wasters CI . . .	112 „ 115	35	225
„ XI . . .	140 „ 143	43	

CHAPTER VIII.

PAPER ON THE MANUFACTURE OF TIN-PLATES, BY MR. EBENEZER ROGERS; TAKEN FROM THE REPORTS OF THE SOUTH WALES INSTITUTE OF ENGINEERS, 1857.

AFTER a brief and very imperfect reference to the introduction of the trade from Bohemia Mr. Rogers proceeds to state that—

About the year 1720, works for the manufacture of tin-plates were established at Pontypool, and these seem to be the earliest of such works in England, as were permanently successful. In 1728, John Payne invented a process for rolling, and this seems to have at once led to the use of flat or sheet rolls for the manufacture of iron for tin-plates; but it is very remarkable that no further progress was made in this discovery of rolling iron until 1783, when Henry Cort invented the grooved rolls.

This discovery was not appreciated for some years. Mr. Reynolds, of Ketly, erected Cort's rolls in 1785. In 1790, Henry Cort was engaged by Mr. Richard Crawshay to erect the mills at Cyfarthfa, and soon after this important improvement in the iron manufacture was generally adopted. The writer purposes to give in this chapter a short résumé, first, of the process of cleaning and tinning the iron plate, and afterwards of the methods of preparing the iron for this purpose.

The affinity of iron for tin is much greater than generally supposed. The points at which the metals cohere is no doubt an actual alloy, and advantage is taken of this by the manufacturers of iron articles for domestic use, such as bridle bits, common stirrups, small nails, &c.

When the iron, whether wrought or cast, is perfectly clean and free from rust, and brought in contact with melted tin, at a high temperature, an alloy seems to be at once formed, protecting the iron from oxidization whilst the tin lasts. Many different ways of tinning iron articles of small size are adopted by the manufacturers. One of the common methods of coating bridle bits and small ware with tin, in South Staffordshire, is—to clean the surface of the articles to be tinned by steeping them for sufficient time in a mixture of sulphuric and muriatic acids, diluted with water; then to wash them well with water, and, taking great care that they do not rust, at once placing them in a partially closed stoneware vessel (such as a common bottle), which contains a mixture of tin and muriate of ammonia. This vessel must then be placed on a smith's hearth, duly heated, and frequently agitated to secure the complete distribution of the tin over the iron. The articles when thus tinned are thrown into water to wash away all remains of the sal-ammoniac; and lastly, cleaned in hot bran or sawdust to improve the appearance for sale.

The method of cleaning and preparing the iron for tinning has undergone many changes in the past century. About 1720, the plan of cleaning was to scour the plates with sand and water, and file off the rough parts, then to cover them with resin, and dip them in the melted tin. About 1747, the plates were, after being cold rolled, soaked for a week in the lees of bran which had been allowed to stand in water about ten days, to become by fermentation sufficiently acid, and then scoured with sand and water. In 1760, the plates were pickled in diluted muriatic acid before annealing, and cleaned with diluted sulphuric acid, after being taken out of the bran lees. An improvement of great importance in this process was made about 1745, the inventor seems to have been Mr. Mosely, who carried on tin-plate works in South Staffordshire. This invention was the use of the grease-pot, and in this department little, if any, improvement has since been made. The plan was introduced into South Wales in 1747, by Mr. John Jenkins, and his

descendants are still amongst the principal manufacturers in the trade. The process of cleaning and tinning at some of the best works now is as follows: when the sheet iron leaves the plate mill, after separating the plates and sprinkling between each plate a little sawdust (the effect of which is to keep them separate), they are immersed, or, as technically termed, "pickled" in diluted sulphuric acid, and after this, placed in the annealing pot and left in the furnace about twenty-four hours; on coming out the plates are passed through the cold rolls; after passing the cold rolls, the plates seem to have too much the character of steel, and not sufficiently ductile; to remedy this they are again annealed at a low heat, washed in diluted sulphuric acid, to remove any scale of oxide of iron, and scoured with sand and water; the plates in this state require to be perfectly clean and bright, and may be left for months immersed in pure water without rust or injury, but a few minutes' exposure to the air rusts them. When perfectly clean they are taken to the tinman's pan, which is full of melted grease. In this the plates are immersed, and left there until all aqueous moisture upon them is evaporated, and they are completely covered with the grease; from this they are taken to the "tin pot" and then plunged into a bath of melted tin, which is covered with grease; but as in this first dipping the alloy is imperfect, and the surface not uniformly covered, the plates are removed to the dipping or wash-pot; this contains a bath of melted tin covered with grease, and is divided into two compartments; in the larger compartment the plates are plunged, and left sufficiently long to make the alloy complete, and to separate any superfluous tin which may have adhered to the surface; the workman takes the plate and places it on the table, and wipes it on both sides with a brush of hemp; then, to take away the marks of the brush, and give a polish to the surface, he dips it in the second compartment of the wash-pot. This last always contains the purest tin, and as it becomes alloyed with the iron it is removed on to the first compartment, and after to the "tin pot." The plate is now removed to the "grease-pot;" this is

filled with melted grease, and requires very skilful management as to the temperature it is to be kept in. The true object is to allow any superfluous tin to run off, and to prevent the alloy on the surface of the iron plate cooling quicker than the iron. If this were neglected the face of the plate would be cracked. The plate is removed to the cold pot; this is filled with tallow, heated to a comparatively low temperature. The use of the grease-pots, is the process adopted in practice for annealing the alloyed plates. The list pot is used for the purpose of removing a small wire of tin, which adheres to the lower edge of the plate in all the foregoing processes. It is a small cast-iron bath, kept at a sufficiently high temperature, and covered with tin about one-fourth of an inch deep. In this the edges of the plates are dipped and left until the wire of tin is melted, and then detached by a quick blow on the plate with a stick. The plates are now carefully cleaned with bran to free them from grease. Lastly, they are taken to the sorting-room, where every plate is separately examined and classed, and packed in boxes for market as hereafter described.

The tests of quality for tin-plates are—ductility, strength, and colour. To obtain these the iron must be of the best quality, and the manufacture must be conducted with proportionate skill. This necessity will explain to some extent the cause why nearly all the improvements in working iron, during the past century, have been either originated or first adopted by the tin-plate makers, and a sketch of the processes used at different times, in working iron for tin-plates, will be, in fact, a history of the trade. The process of preparing the best charcoal iron seems to have undergone but little change from 1720 to 1807. The finery, the chafery, and the hammer, were the modes of bringing the iron from the pig to the state of finished bars. The finery was of the exact form but smaller than those now used. The chafery or hollow fire was, in fact, the same as the present smith's forge fire, but on a larger scale, and the "hollow" or chamber, in which the bloom was heated, was made by coking the coal in the centre with the blast, and taking care not to disturb

the mass of coal above, which was used to reverberate the heat produced. Both the finery and chafery were worked by blast.

The hammers were of two descriptions: the forge hammer a heavy mass for shaping the blooms, and the tilt hammer, much lighter, and driven quicker for shaping the bars.

The charge for the finery was about 1½ cwt. of pig iron: this under the first process was reduced to 1¼ cwt. It was, when ready, put under the forge hammer, and shaped into a bloom about 2 feet long and 5 inches thick; this was then heated in the chafery, and, under the tilt hammer, drawn out to a bar 3 to 4 inches wide, and half an inch thick.

The manufacture up to this point, until a recent period, was carried on by the ironmasters, and the iron in this state was sold under the name of "tin bars" to the platemakers. The average price for these bars, from 1780 to 1810, was £21 per ton. The sheet and cold rolls were then in use nearly as at the present time.

In 1807 Mr. Watkin George, whose position had been established as one of the first engineers of his time, by the erection of the great water wheel and works, at Cyfarthfa, removed to Pontypool, and undertook the remodelling of the old works there. His genius was equal to the task. He clearly saw that the secret of the manufacture was to produce the largest possible quantity with least possible machinery and labour. His inventions to this end worked a complete change in the trade. His plans were to first reduce the pig iron in a finery under coke, and then bring this "refiners' metal" (so termed) into the charcoal finery.

A charge of 3 cwt. of iron was used in this, and as it became malleable, it was reduced under the hammer to what he termed a "stamp;" this was a piece of iron about one inch thick, and of any shape horizontally. It was next broken in pieces of a convenient size, and about 84 lbs. were "piled" on a flat piece of tilted iron, with a handle about four feet long. This rough shovel or holder was called "portal" or the "staff."

To reheat this "pile" in the chafery would be a work of great cost and difficulty, and the brick hollow fire was

invented. This is, the writer believes, one of the inventions which, although in work during the past fifty years, still points to very great improvements in the manufacture of iron. It is in substance the plan of using the gases produced by the decomposition of fuel for the working of iron.

The charcoal finery is also worked by the use of the gases to a much greater extent than is generally known. The workman sends his blast directly into the mass of iron, and the charcoal seems to be simply the means by which he is better enabled to manipulate the iron in the finery, and keep it covered so as to revive the oxidized metal, and thus prevent waste. A few hours spent with any intelligent workman, at the side of his charcoal finery, would show the wasteful and expensive character of the so-called "new" schemes for converting cast into wrought iron by the use of air alone. The late belief in these schemes, by men of high repute and practical knowledge in the trade, is a direct proof of the deficiency in knowledge of exact science, as at present applied to the manufacture of iron.

The pile was now placed in the hollow fire, and brought to a soft welding or washing heat, again hammered out to "slabs" six inches wide and three-quarters of an inch thick; these were reheated, cut up and afterwards passed through rolls, reducing them to "bars" six inches by half an inch. These were known in the trade as "hollow fire iron" or "tin bars." The result of Mr. Watkin George's improvements was, to reduce the cost, and double the production with the same outlay in machinery. All the tin plates made at this time had the great defect of a rough and smooth side.

In the year 1820, Mr. William Daniell (a gentleman still living, to whom for his inventions the trade is and will be under great obligation) found a mode to remedy this defect. Himself a maker of tin bars and plates, he had observed that the smooth side of the plate was always that corresponding to the flat part of the "portal" or "staff;" he at once, having ascertained this cause, remedied the defect by hammering out the pile, notching it, and doubling it over, so that the tilted blade of the staff was on the top as well as the bottom of the

pile. This was the invention of "tops and bottoms," and the writer need not remind practical men of the immense sums made by this discovery during the past thirty-seven years.

Another improvement since 1807 is the use of the running-out fire: it is still adopted only in a few works. This process saves waste of heat and labour by running the refined metal at once into the charcoal finery.

The "tin bars" before referred to, 6 in. by ⅛ in., are heated and run through rollers until they form a sheet of sufficient width; this sheet is then doubled and passed through the rolls, and the process is repeated until this sheet is quadrupled. The laminæ are then cut to size and separated as before described. The writer asks careful attention to the fact, that the last part of the rolling is done when the iron is nearly cold. These sheets are next annealed, and were formerly bent separately, by hand, into a saddle, forming two sides of a triangle, thus Λ, and placed in a reverberatory furnace, so that the flame should play amongst them, and heat them to redness; they were then plunged into a bath of muriatic acid, or sulphuric acid, and water for a few minutes, taken out, and drained on the floor and again heated in a furnace, after which, a scale of oxide of iron separated from the plate, during the work of bending them again straight, on a cast-iron block.

The plates should be now free from rust or scale, and are passed cold through the chilled rolls; this last process is most important, as the ductility and the strength and colour of the tin-plate depend upon it: at this point bad iron will crack or split, and any want of quality in the iron, or skill in the manufacture, will be shown.

A great improvement in the process of annealing was made in 1829 by Mr. Thomas Morgan; the plates were piled on a stand, and covered with a cast-iron box, now termed an "annealing pot;" in this they were exposed to a dull red heat, in a reverberatory furnace, for twenty-four hours.

A very important invention in the manufacture of iron for tin-plates, and which is yet only partially carried out, was made by Mr. William Daniell in 1845. About 2½ cwt. of

refined metal is placed in the charcoal finery; this is taken out in one lump, put under the hammer and "nobbled," then passed at once through the balling-rolls and reduced to a bar 6 inches square and about 2 feet 6 inches long. This bar is either cut or sawed off in pieces 6 inches long, and these rolled endwise to give a bar about 6 inches wide, $2\frac{1}{2}$ inches thick, and 12 inches long, and in this state the inventor calls it a "billet." This is heated in a small balling-furnace, and rolled down to a bar one-quarter inch thick and eleven inches wide, and about six feet long. This is taken at once to the tin-plate mill, and the process saves great expense in fuel and machinery. By the old method of annealing, a box of tin-plates required about 13 lbs. of tin.

This is now done with about 9 lbs. for charcoal and 8 lbs. for coke-plates.

In referring to tin-plates the standard for quotation is always taken as 1 C. (Common No. 1.) This is a box containing 225 plates, which should weigh exactly 112 lbs.

The following are the Marks, Weights, and Measurement, of the Tin-plates now in common use:—

Names.	Sizes.	No. in a Box.	Weight of each Box.	Marks on the Boxes.
	inches.		cts. qrs. lbs.	
Common No. 1	$13\frac{3}{4} \times 10$	225	1 0 0	CI.
„ „ 2	$13\frac{1}{2} \times 9\frac{1}{2}$	„	0 3 21	CII.
„ „ 3	$12\frac{3}{4} \times 9\frac{1}{2}$	„	0 3 16	CIII.
Cross „ 1	$13\frac{3}{4} \times 10$	„	1 1 0	XI.
Two Crosses „ 1	„ „	„	1 1 21	XXI.
Three „ „ 1	„ „	„	1 2 14	XXXI.
Four „ „ 1	„ „	„	1 3 7	XXXXI.
Common Doubles	$16\frac{3}{4} \times 12\frac{1}{2}$	100	0 3 21	CD.
Cross Doubles	„ „	„	1 0 14	XD.
Two Cross Doubles . . .	„ „	„	1 1 7	XXD.
Three „ „ . . .	„ „	„	1 2 0	XXXD.
Four „ „ . . .	„ „	„	1 2 21	XXXXD.
Common Small Doubles . .	15 × 11	200	1 2 0	CSD.
Cross „ „ . .	„ „	„	1 2 21	XSD.
Two Cross „ „ . .	„ „	„	1 3 14	XXSD.
Three „ „ „ . .	„ „	„	2 0 7	XXXSD.
Four „ „ „ . .	„ „	„	2 1 0	XXXXSD.
Waster's Common No. 1 . .	$13\frac{3}{4} \times 10$	225	1 0 0	WCI.
„ Cross No. 1 . . .	„ „	„	1 1 0	WXI.

CHAPTER IX.

Andrew Yarranton.

It will not now perhaps be out of place to give some account of Andrew Yarranton, Gentleman, the Father of English Tin-plates, and also the Founder of English Political Economy.

Dove, in "Elements of Political Science," very truly says of him that he was the first man in England who saw, and said that Peace was better than War; that Trade was better than plunder, that honest industry was better than martial greatness, and that the best occupation of a government was to secure prosperity at Home, and to let other Nations alone.

The first part of Yarranton's great work entitled "England's Improvements by Land and Sea," published in 1677, is now very rare, and the second part, published 1681, containing an account of his discoveries and ideas with regard to the Manufacture of Iron and Tin plates, is very scarce indeed, and the book is not to be found in the Libraries of the British Museum, nor in the Bodleian at Oxford, nor in the Radclyffe, at Manchester.

The great idea of Andrew Yarranton's life was that England (by Trade) should beat the Dutch without fighting, and his fancy for beating the *Dutch* more particularly, possibly from the fact that when he was in Saxony on his journey of discovery, the News arrived from England that the Dutch, who by their Trade to the East Indies were becoming fabulously rich and prosperous, flaunting, as he said, their new born Flag on the waters of Father Thames, had burnt our Ships at Chatham.

Mr. Yarranton informs us that, to beat the Dutch by Fighting is difficult, by reason of the great advantages which they possess by their Sands and Holes along the German shore from the Mouth of the Texel unto the Mouth or Influx of the Elbe. But he hoped that the following improvements would eventually enable the English to beat the Dutch without fighting, and would force from them "their beloved Mistress and delight, which is trade and riches thereby."

1. The Improvement of our Linen and Iron Manufactures.
2. The Settlement of our Navigation Laws.
3. The Establishment of a Public Register for all Lands and Houses.
4. The Cutting Canals and improving the Navigation of our Rivers.
5. A public Bank with a proper issue.
6. A Court of Merchants to decide between Merchant and Merchant.
7. A Lumber House where money should be lent on goods at easy interest.

The Book itself being now so very rare, and the contents so ably written, full of sound masculine common sense, the Writer is unwilling to attempt any Epitome, but, in order that those who are interested may read for themselves, prefers to give a verbatim copy of Mr. Yarranton's ideas and thought on the manufacture of Iron and Tin plates printed and published in London almost 200 years ago.

First, will be found the very interesting and explicit Title page of the Work, then his explanatory address to his Readers, then his apologies and excuses for his delay in reporting himself to the Noble patriots who had sent him abroad, then his History of himself, and finally from his second part a Copy of the Chapters relating to the Manufacture of Iron and Tinn.

ENGLAND'S IMPROVEMENTS

BY

SEA AND LAND;

TO

Out-do the Dutch without Fighting;

TO

PAY DEBTS WITHOUT MONEYS;

TO SET AT WORK ALL THE POOR OF ENGLAND WITH THE GROWTH OF OUR OWN LANDS;

TO PREVENT UNNECESSARY SUITS IN LAW, WITH THE BENEFIT OF A VOLUNTARY REGISTER;

DIRECTIONS WHERE VAST QUANTITIES OF TIMBER ARE TO BE HAD FOR THE BUILDING OF SHIPS, WITH THE ADVANTAGE OF MAKING THE GREAT RIVERS OF ENGLAND NAVIGABLE.

RULES TO PREVENT FIRES IN LONDON AND OTHER GREAT CITIES, WITH DIRECTIONS HOW THE SEVERAL COMPANIES OF HANDICRAFTSMEN IN LONDON MAY ALWAYS HAVE CHEAP BREAD AND DRINK.

BY

ANDREW YARRANTON, GENT.

LONDON:

Printed by R. EVERINGHAM, for the Author, and are to be sold by J. PARKHURST, at the "Bible and Three Crowns" in Cheapside, and N. SIMMONS, at the "Princes Arms" in St. Paul's Churchyard.

M.DC.LXXVII.

"THE EPISTLE TO THE READER.

READER,—"Thou must take Notice that all Kingdoms and Commonwealths increase in strength and riches according as they are situated for trade, and do convenience themselves with just and equal laws and customs whereby they out-do the rest of their Neighbours. We see of late years what great contests and bloody wars have been betwixt England and Holland, and all to obtain the Mistress called Trade. Sometimes the English Merchants complaining how the Dutch out-trade them, and that they are not able to live, And so in process of time they and others, under pretence of ascertaining the Merchants' Rights, blow up a War betwixt England and Holland, which hath seldom been composed with a peace but the Merchant goeth by the worst, and the people of England seldom bettered, or the trade advanced, And it being my fortune to be travelling and at Draysdin, the Duke of Saxony's Court, when the sad News came of the Dutch burning our Ships at Chatham, I made it then my business, amongst other things I was employed in, to observe as far as I could how and which way the trade of England might be improved and advanced, And when I had made my observations of the trade there, and how far it was to be taken Notice of in order to the establishing of the like in England to set the poor on work, which was the linen, thread, tape, and tin-plates, I came from Holland, being the time the treaty was at Breda, when the triple league was concluded (viz.) between England, Holland, and Switheland, and there spending some time in the observations of their laws, customs, public Banks, cut Rivers, Havens, Sands, policies in Government and Trade, with their natural fortification both by Sea and Land, weighing and considering all things. I was then satisfied we could not beat the Dutch with fighting, And by long studying and weighing every part of their condition, and also knowing some of our failings in the advance of Trade and our weak laws conducing thereunto, I did see that all was out of joint, and pursuing the causes thereof, in a

small time it appeared to me that, although we could not beat them with fighting, yet on the other hand it was as clear to me that we might beat them without fighting, that being the best and justest way to subdue our enemies.

"My fancy growing higher and higher, and knowing it might be acceptable service to the public good of the Kingdom, I discoursed all parts and points now writ some hundreds of times, with some Lords, some Judges, Lawyers, Gentlemen, Merchants, Sea Officers, and Courtiers, and upon all that I ceuld hear, and receiving all that could be said against it, I was the more confirmed it might be done, upon which I was encouraged by many, and some of them Lawyers, who offered me their assistance and help to make it ready for the press, which I was preparing for; But before I could explain my intentions, I received a letter from a Friend in Flanders, wherein he acquainted me that there would be Wars between France, and England, and Holland, and that the Dutch would be in great danger, and in process of time Flanders also, and that France and England would join against Holland; upon which I made a Map, and put the English in two Squadrons at half Sea, and the French in one Squadron with them, and I put the Dutch in three Squadrons within their Sands and natural Holds, and did in the same Map underwrite the reasons here set down in this treatise (why we might beat them without fighting), which Map was done three weeks before the breach was, which is ready to be produced if by any desired. And I did then at Whitehall, and in many other places, show by discourse the little fruits we might expect and the great danger might ensue in breaking the balance of Europe, it being then indifferently settled. But the balance being now broke, and understanding the Duchies' preparations (as to build great ships), I am satisfied they aim at a larger trade than ever when opportunity offers itself, and will endeavour to carry the flag in the Eastern Seas, and its possible somewhere else, if not prevented by the English. Therefore these few sheets are set abroad to show the World how they may be beat without fighting, and by no other ways than the free lands of England being put under

a Voluntary register by Act of parliament. From the Credit whereof spring Banks, Lumberhouses, with all Credits necessary to drive Trade, cut Rivers, the fishery, and all things else that Moneys are capable of, and it will drive away the great feuds and complaints rooted in the hearts of the people as the decay of Trade, the growing power of the French, and much more."

To Sir Walter Kirkham Blount, Baronet; Sir Samuel Baldwin; Sir Timothy Baldwin, Knights; Thomas Foley; Philip Foley, Esquires; Thomas Smith, Esquire; Joseph Newbrook; Samuel Whyte; Nicholas Baker; John Finch, and Nicholas Harrison, Gent.

"My noble Patriots—That I have not returned you an earlier account of those Travels, in which out of a pure love to your Country you were pleased some years since to employ me, I had rather in a few words submit to your just reprehension than by making a tedious Apology tell my Readers a long story that little or nothing concerns them. It is, I hope, sufficient that I acquaint them, that if from the remarks I have made on the Balance of Europe, or my studious prying into the curious intreagues of Trade, and the thriving politics of our Neighbour Nations, any advantage shall arise unto us in this Kingdom, they must with me return their acknowledgements wholly to you, whose generous souls not only engaged me at first in the undertaking, but also wholly maintained me and my Interpreter throughout my travels in the quest of such things, as my own fortune would have proved too slender to have otherwise acquired; but that I may not be condemned with the Sluggard for laying up my talent in a Napkin, I herewith present you also an account of my choicest observations and practice for this twenty-five years in trade, in which such secrets as the benefit of your Moneys gave me the advantage of finding out abroad, are at length by great pains and study rendered all practicable here at home, and so adapted to our own Climate and Constitutions,

that nothing but Sloth or Envy can possibly hinder my labours from being crowned with their wisht for success. Our habitual fondness of the one hath already brought us to the brink of Ruine, and our proneness to the other almost discouraged all pious Endeavours to promote our future happiness: people confess they are Sick, trade is in a Consumption, the whole Nation languishes, and the physic prescribed is very proper and good but some like not the Season, and fain would put it off (like repentance) still a little longer, until at length it be too late. Others fancy not the Doctor, and so resolve not to like it because his advice. All that I shall say to both these is, that the obstructors of our happiness will purchase to themselves as many hard thoughts from their ruined posterity for hindering the increase of wealth, honour, and honesty, amongst us as your wisdom will create you blessings, for your study, care, and liberal expenses to promote so Noble a design. And if by what I here present you, you find I have discharged my trust like a faithful Steward, your approbation, as it will be the best security against the Captious, it is likewise the highest Ambition of,

"Gentlemen,

"Your sincere and most humble Servant,

"ANDREW YARRANTON."

CONSIDERATIONS UPON THE IRON MANUFACTURE.

"CONSIDER,—That the best Iron in the known world is in the Forest of Dean, and in the Clay Hill in Shropshire, and the iron made of these minerals will work most easiest and quickest into Commodities of any iron, and at present let there be one Tun of this Bar Iron made of Forest iron stone, and one Tun of Spanish Iron delivered to a Smith to work into sythes, sickles, and other Commodities, he will work the Forest iron, and give twenty pounds the tun for it, but will not give twenty shillings for the tun of Spanish Iron to work into

Commodities. The Forest iron works easie, plyable, and soft; the Spanish works tough, churlish, and dogged.

"Consider, if there be not timely course taken by the parliament to provide for the inclosure of the Commons in these parts which lye convenient to these Iron Mines and Works to increase Woods, in a very small time the manufacture will be much lessened, and will prove the great impoverishing of the Countreys where now they are, and of much damage to the Kingdom in general.

"Consider, that in Worcestershire, Stafford, and Darbyshire, there are great mines of Iron-stone that makes Iron, not very good for use for all things, but of excellent use for Nails, and many small Commodities, the benefit of which trade is of great advantage to all the Countries round about; And in these Countries there are great quantities of pit Coles, which are in all places near the Ironworks, and by the help of the Coal the iron is manufactured with ease, cheapness, and advantage, whereby we have the trade of good part of Europe for these Commodities, and so set infinite of poor people to work.

"Consider, the Woods in these parts decay and look thin and will not last long, and when gone the Iron-stone and Coles will be there of no value, the people unemployed, the Trade lost, therefore the vast Commons in these parts inclosed for Woods would prevent all. As the Duke of Saxony hath done near Anaburgh and Sneburgh, where these politic preservation of woods in Lands, joyning to his Iron, Tin, Silver, and Copper Mines, hath made them a very great branch of his revenue, and all the Country round about by the multitude of people employed, are become very rich, and these things in point of convenience as to Iron works."

"Tin Works, with mines and woods to supply the works, are so ordered that there are at present Manufactured many Commodities in Iron, and sent into England. If these woods had not been preserved by a public law, all his Mines had been nothing worth, and the Iron Trade and Works would have continued near Newringburgh, from whence they now are departed, and that great benefit is now wholly enjoyed

by the Duke of Saxony; The like it will do in few years if the Commons are not inclosed, for Woods in the Countrys I name, when there is Iron stone and pit Cole plentiful are as the Breast is to the Child, let that cease, all dies.

"Consider, A Tax being laid upon Barr Iron and wrought Iron will increase the Iron Manufacture here, whereby the prices of Woods will be increased, the Lands rise price, and the poor employed, and all materials, both Mine pit Cole and Woods, are of our own growth and product.

"Consider how many Iron works are laid down both in Kent, Sussex, and Surrey, and many more must follow. The reason is, the Iron from Sweadland, Flanders, and Spain comes in so cheap that it cannot be made to profit here, and observe how the Gentlemen and others in the Countreys for want of moneys for their Woods, are forced to stock up their Copices and turn them into Tillage and pasture, the people unemployed, and their lands fall Rents. To prevent all, a Tax upon Foreign Iron is absolutely necessary.

"Reader, I beg thy pardon, if I have kept thee long in reading this discourse, but I hope thou wilt not be angry, for when I put pen to paper I intended to be brief.

"I know there are many before they have well weighed the Contents of this Book, will think that it may much shake their interests, and so will be enquiring after the Compiler and of his education, and how it is possible that one Man should know all that is in this Book asserted, and will say these are notions of a hot brain. I know others whose sores are great, and wounds dangerous, and desire a cure thereby to live at peace (both in their Estates and persons), will be apt to ascribe more to the Compiler than is due. For in this age most of the present humours are to detract and abuse, when interest is pinched or laid open to the World, and on the other hand too much to cry up and extol those that expect benefit and relief. As to both sorts of Inquisitors, I will save them a labour and give them a short account of my education and improvement. I was an Apprentice to a Linnen Draper when this King was born, and continued at the Trade

some years, But the Shop being too narrow and short for my large mind, I took leave of my Master, but said nothing. Then I lived a Country life for some years, and in the late Wars I was a Soldier, and sometimes had the honour and misfortune to lodg and dislodg an Army.

"In the year 1652, I entred upon Iron Works and folo'd them several years, and in them times I made it my business to survey the three great Rivers of England and some small ones, and made two Navigable, and a third almost compleated. I next studied the great weakness of the rye lands, and the surfeit it was then under by reason of their long Tillage.

"I did by Practick and Theorick find out the reason of its defection as also of its recovery, and applyed the remedy in putting out two Books which were so fitted to the Countryman's capacity, that he fell on pell mall, and I hope and partly know that great part of Worcestershire, Gloucestershire, Herefordshire, Shropshire, and Staffordshire have doubled the value of the land, by the Husbandry discovered to them,—see my two Books printed by Mr. Sawbridg on Ludgate Hill, entitled 'Yarranton's Improvements, by Clover,' and 'There thou maist be further satisfied.' I also for many years served the Countreys with the Seed, and at last gave them the knowledge of getting it with ease and small trouble; and what I have been doing since, my Book tells you at large, And as to any that are my Enemies upon the account of this subject or of such as speak or assert my pains to be to them acceptable, both parties are to me alike; I only wish and pray that what is here treated upon may by the powers above us be seriously considered of; and if it be found it tends to the benefit of this present age, and for the good of the generations to come, then let them pursue the ends to bring it to pass. If any Gentleman or other please to put pen to paper in opposition to what is here asserted, I shall give him a Civil return, bound up with the second part, when these seven heads shall be treated on."

CHAPTER X.

THE IMPROVEMENT OF OUR IRON AND TINN BY CONVERTING AND MAKING IT INTO PLATES COMMONLY CALLED TINN-PLATES.

[*Extracted from 'England's Improvements by Sea and Land.' By Andrew Yarranton, Gent. Published in London*, 1677.]

"THE IRON AND TINN IMPROVEMENTS LAID OPEN TO PUBLICK VIEW WITH MEANS AND WAYES TO BE US'D, FOR OBTAINING THE TRADE OF MAKING TINN PLATS, WITH THE FOREST OF DEAN IRON, AND THE CORNISH TINN; THEREBY TO IMPLOY OUR POOR, AND ENCOURAGE OUR EXPORTED TRADE, MADE OF OUR OWN MINERALS, WHEREIN IS ALSO OBSERVED THE DANGER WE ARE IN, FROM SUPERNUMERARY PRIESTS AND FREE SCHOOLS, AS THE CASE NOW STANDS; WITH A WAY PROPOSED FOR RELIEF IN THAT AFFAIR, THAT THEREBY LEARNING MAY NOT BE A BURDEN TO THE NATION AND DESTRUCTIVE TO THE SCHOLARS.

"THE Employment of the poor, and the Manufactures of all Nations, ordered and fitted to the best advantage, are of no small Benefit to the publick: and in all parts, where there are good things, either as Minerals that may (with ease) be taken out of the Earth, or such other things that are the Growth and product of the Lands being unimployed (or are not well understood) how they may be Employed, for the Good and Benefit of that place where such things abound, it must of necessity have Two sad and evil effects attending thereon.

"As, First, such a Nation will be continually necessitated to fetch in all such things from Foreign Nations, whereby the Importation thereof may Exceed their Exportation, which is of great Danger, and hath several mischiefs attending thereon: and it were to be wished that it could not he reckoned at present one of the least among the rest of our Miseries, of

which I shall hereafter make a Discovery, when I speak of improving England by the Woollen and Linnen Trade.

"Secondly, The Neglect of the Improvements of those Minerals and Manufactures, are the Causes of the Lowness of the prices and Rents of Lands, increases the poor, and brings a Decay in Shipping, and Commerce and by Consequence weakens that Nation and makes others Rich and Strong to their Detriment.

God and Nature hath fitted us with two most Advantageous Minerals in this Nation for the procuring of Wealth and Riches and putting the poor on work and in places so well posted (for quickness and ease and Carriage and re-Carriage by Sea) that it would make men amazed that those Minerals should (at this time) be under No Better Improvements. One of these Rich (Yet Neglected) Minerals, is our Tinn in Cornwall, which place lies upon the Sea, and thereby the Commodity may (at all times) be Shipt, either on the French and Spanish Coasts or for Ireland. And at this time that Commodity of Tinn is so Low, that in Cornwall Tinn gives not above Three pounds ten shillings the hundredweight. The Second Mineral is the Roman Cinders and Iron Stone, in the Forrest of Dean in the County of Glocester, which makes the best Iron for most uses in the World, and works up to the best Advantage, with delight and pleasure to the Workman. This Mineral is in Glocestershire, where the River Wye, and the River Severn, washes the East and South sides thereof, even as the Irish and Narrow Seas doth Cornwall. And from both these parts Tinn and Iron-stone may be transported by Sea with ease, and small Charge, unto any place where Materials are capable and fitting for the improving thereof; and knowing the usefulness of the Tin-plates, and the goodness of our Mettals for that purpose, I did (about Sixteen years since) endeavor to find out the Way for making thereof, they being made of Hammer'd Iron and then made Bright (and Tinn'd over); Whereupon, I acquainted a person of much Riches, and one that was very Understanding in the Iron Manufacture, who was pleased to say, That he had often designed to get that Trade for making Tinn-plates into

England, but never could find out (by any) the way of Making them. Upon which, it was Agreed, That a Sum of monies should be advanced (by several persons) for the defraying my Charge of Travelling to the place where these plates were made; and from thence, to bring away the Art of making them: Upon which an Able Fireman (that well understood the whole nature of Iron) was made choice of to accompany me; and being fitted with an Ingenious Interpreter, that well understood the Language, and that had dealt much in that Commodity, we marched first for Hamburg, thence to Lipswick; and from thence to Draisden the Duke of Saxomes Court, where we had Notice of the place where the plates were made, which was in a large tract of Mountainous Land, running from a place called Seger-Hutton, unto a Town called Awe, being in length about twenty Miles, the Tinn Works being there fixed up on a Great River, running clear along the Valley, and also upon some little Rivilets that run out of the Mountains of Bohemia and Saxony; And coming to the Works, we were very civilly Treated; and contrary to our Expectation, we had much liberty to View and See the Works Go, with the way and manner of their Working and Extending the plates, as also the perfect View of such materials as they used in Clearing the plates to make them fit to take Tinn with the way they use in Tinning them over, when cleared from their rust and blackness; And having (as we judged) sufficiently obtained the whole Art of Making and Tinning the plates, we then came for England, where the several persons concerned in the Affair, thought fit to make some Trial in making some small quantities of plates, and Tinning them, which was done; and several parcels were made, and sent to London, to the Tinn-man for Trial and Approbation; and many sent to Worcester to be Wrought up by a Tinn-man there; And all Workmen that wrought upon them, agreeing, That the plates, and the Mettal they were made of was much better than those plates which were made in Germany, and would work more pliable, and serve for many more profitable uses than the German plates would do; Upon which, preparation

was making to set this Beneficial thing at work for the Improvement of our own Minerals, and setting the Poor at Work. But it being understood at London (and as commonly it doth in all these cases) a patent was trumpt up, whereby this making of Tinn-plates was granted, and the patentee was countenanced by some persons of quality: And many persons then of Interest endeavouring to get an Act of Parliament for making thereof, and to Appropriate it (as in some other cases it hath been done) to some particular men; And what with the patent being in our way, and the Richest of our way, and the Richest of our partners being not willing, or at least afraid to offend Great men then in power, who had their eye upon it, caused the thing to cool, and neither the making thereof proceeded by us nor possibly could be done by him that had the patent with such as countenanced it, the thing lying under so many several circumstances: As:

First, Fit and convenient places to Build Works.

Secondly, The knowledge of the fittest iron to be used in making the plates.

Thirdly, Refining of the Tin and fitting it for present Use.

Fourthly, Present Stocks to carry on so great a work because neither he that hath the patent, nor those that have countenanced him, can make one plate fit for Use: For, he that can make One plate, may make Thousands, And by way of digression I make these Queries upon patents, because I know they commonly drive Trade out of the Kingdom.

Whether this patent for making Tinn-plates is in force, the patentee having made none since the Granting thereof?

And Whether this patent be in force, if renewed since Tinn-plates were made by others?

Whether Patents (for making any sorts of Glass) be not void because Glass was made before, and it is but Improvement of Art? Patents are by the Statute for New Inventions, that is, all New?

Whether a patent for pumps be not void, pumps being made before that patent was granted: it is only Improvement of Arts?

Whether a patent for Whitning of Hemp and Flax be not Void, our Mother Eve, its possible, did some, and many an old woman (since her time) have Improved that Art, as far as her understanding would reach?

Whether a patent for making Mills to Grind Apples to make Sider, be not void, for there were many Sider Mills in Kent, Hereford, Glocester and Worcestershire before. It is the improvement of Art. And so I may make Queries of most Patents granted in other things because the Statute that gives the King power to grant patents for fourteen years, Limited it wholly to a new Invention: for it must not be putting a new piece unto an old Cap that must serve turn, but some will say, that there is nothing new under the Sun and a Wise Man said it: But the question with us will be whether it be new, and all, and every part of the Invention new in this Nation? and if so, questionless it is within the meaning of the Statute, I would not be understood to be against a patent due by the Law nor be against a Liberal Reward to be given to Ingenious persons, that find out or invent things which are for the good of the publique; but rather, that they may have from the publique, Incouragements, by finding out such Discoveries. But I am against all such persons to their practices, that get patents upon pretention of benefiting the publick, and so creep into some great men to favour the business, and next, to gather up some young Cullies and squeeze them till their purses are as dry as their Brains, and possibly, if any of these patents are put in Execution much mischief happens to the publick, as soon as the commodity is made Serviceable, or as I may say, serving the publick: the things made under the patent must be Dear, because some great men have shares therein; and because there hath great charges been laid out, at least so pretended, which was to bring the work to perfection, and when the dearness of the Commodities made under a patent comes to be sold, and the great Gains made thereof, comes to be discovered, and no one else then may set up the same Invention (because the making thereof is limited to certain persons) Then commonly it falls out, that some that are dealers in

these things made by vertue of the Patent beat their Brains and are turning every Stone to find where these Commodities may be made Cheaper than by the patentee, although out of England, and at last they fix to set it on foot either in New-England, Virginia or Ireland, and then they comply with a Workman or two of the patentees as easily they may do, they being persons generally travelling from place to place to spring new gain and so carry that Art quite away into another Nation where the Materials are cheaper, and things better fitted for the purpose; so that the dearness of the Commodities made under a Patent generally produces these bad Effects.

First, Carrying the Art and Mystery with the Benefit thereof quite out of the Nation.

Secondly, The Patentee have the honour, to sell up his small remainders of Goods at a Cheap Rate, although made Dear, and to leave the Edifices, and things made by him a great Charge, for People (its possible, ten or twenty years after) to say what hath been doing here; But I know it would be of no small Benefit to the Nation, if there were a Society of Persons Incorporate that might Inspect, Advise, Travel, and present to authority, the best means, wayes, and manner of Improving the Manufacture and Minerals of England, that the benefit thereof might be Rightly Applyed, and if the Schollars of one of the Houses in Oxford, and another in Cambridge, were Exercised therein, I know they would bring much more good and benefit to the Publick, and to themselves and Families, than they do at present to the Church, and the Law, both being so much over-stockt. I observed when I was in Saxony, that the Works for making Tin-plates were many, and most of them were belonging unto the Duke of Saxony, only some few that did belong to the Emperor, and the River upon which most of the Tin-works were fixed was upon that River which doth divide Saxony and Bohemia and were there adjoyning: The Tin was found out by a Cornish man which was Banisht out of England upon the account of Religion. And if Peter Hyling speaks truth, there was no Tin known in Europe

but only in England, before that Discovery was made in Germany, some of which Tin I brought away from thence, and trying it with the English Tin, as to the standard, I found the English Tin much better than the German: and the Forest of Dean Iron doth as far exceed the Saxon Iron in Goodness and Fatness as the Forest of Dean Iron Exceeds the Colsbore Iron which is made in Staffordshire, and being satisfied that the Goodness of our Tinn and Iron did far surmount theirs in Germany, and both to be had at far less charge than theirs may or can, even one third penny; the consideration whereof made me travel from place to place to see where this great and beneficial Manufacture might be set up, and how to fit things for the doing thereof, but there being a Pattent in the way, England could not have the benefit thereof.

I went into Ireland, and there spent some time in surveying Rivers and Woods convenient for that purpose, where I find three places very convenient for setting forward that great and beneficial Trade. One whereof is in the County of Kerry, the other near the River Shanon where there are woods sufficient for Ever but at present most part thereof lies Rotting: the other near Clohaman; But the place which I judge most Convenient of the three to answer the Design with Benefit is in the County of Wixlow and Wexford and the part best fixt for bringing Cinders, Iron, Stone, and Tinn unto is Wexford, and thither also may be brought all the plates when made and from thence shipt off into all parts.

Reader, Observe how conveniently the Cinders, Iron, Stones, and Tinn may be brought to the Wood, and how God and Nature hath provided convenient and easy means for joyning these three great things together, whereby they may with much ease be improved to the best Advantage.

First, The Iron, Stone, and Cinders lying in the Forest of Dean, and near the two great Rivers of Severn and Wy; there Ships and other vessels may (at all times) carry these materials from the Forest of Dean to Wexford at a very small Rate not exceeding Twelve shillings the Tun, and from Cornwall to Wexford, the Tinn may be brought for Ten

shillings the Tun and from Wexford Transported up the Slane River unto the Woods.

And if convenient Works were set up there for making of Tin-plates, I know in a short time there might be twenty thousand men Imployed upon that Manufacture, in the Getting, preparing and fitting all things necessary for that Great Affair besides great numbers of Shipping would Constantly be Imployed for Carriage and Re-carriage, all these Heavy and Weighty Commodities which must be used in that Trade: And thereby a great exported Trade will be made into Foreign parts, the Tin-plates and the Vessels made thereof being now a thing in great request even so far as any Trade is known, And all such plates as shall be made with the Forest of Dean Mettal, and Tin'd over with the Cornish Tin, they will be in value but of two thirds the price which they now bye them in at their several Works in Saxony, And when the plates are well made, and Tin'd they are of value here to be sold to the Tin-man, one third penny more than the German plates, are now sold for our Forest of Dean Iron fit to be made into plates at the works in Ireland will be made at £10 per ton, but in Saxony the Iron is at £16 per ton; and our Cornish Tin will be delivered at the Works in Ireland at seventy pound per ton, but the Saxon Tin at their Works is worth £100 per ton and the Charcoal made in Ireland will be delivered at the Works for 12*s.* the Load; but the Charcoal in Saxony delivered at their Works lyes them in 16*s.* the Load and our English Iron and English Tin is much better than theirs is in Saxony: And notwithstanding we have all these great advantages, yet Saxony and part of Bohemia at present serves all the known World with these Tin-plates and that Trade is there become a great Commodity: and thereby all that barren and Mountainous Country is become Exceeding Rich and populous, And these places wherein that Trade is fixt, hath been the occasion of Raising several Brave Cities, As Anaburge, Sneburge, Mareinburge, and many others. And when these Tinn-plates are there made and fitted for sale they are from the works drag'd to the River Elbe it being Land Carriage

at least fifty miles, and good part thereof very Hilly and Mountainous: and then sent down the River Elbe by water to Hamburg, paying several Customs by the way. And from Hamburg they are sent into all parts, even as far as Trade and Commerce is known; And all this while the best Mineral in the World (to make good iron) lyes in this Forrest of Dean unimployed, and the best Tinn in the World, is become a drug and the people belonging to the several minerals (both of Iron and Tinn) much discouraged and unimployed and at present vast and great quantities of Woods Lie Rotting not only in the two Counties named but in several other parts of Ireland also; besides the benefit lost that the Minerals and Woods are capable of Administering by reason of their cheapness and goodness, Also observe the benefit of the Sea which doth so advantageously incourage this affair that even the Tinn and Iron Stone, grows by the very Brinks thereof; and neither of the places (where the Materials of Iron and Tinn are) above thirty hours sail from Wexford in any indifferent wind, and I know this Business of Setting up this Trade of making Tinn-plates may be a thing of great Consequence because it will much people that part of Ireland which lyes nearest France, and would make Ireland to England in these particulars, as Norway is to Denmark."

CHAPTER XI.

A Dialogue Betwixt a Tynn Minor of Cornwal, An Iron Mynor of the Forest of Dean in Gloucestershire, And a Traveller, A.D. 1677.

Trav. "How go on the Iron-works in Gloucestershire in and about the Forest of Dean?"

Iron. "Truly Sir, we just keep Life and Soul together, Some Iron is made, but not the quantity that usually we were wont to make; And as to the Iron Masters they begin to be weary of the Imploy and many of them begin to draw in their Stocks and lessen their Trades; And in some parts of Worcester Shropshire and Staffordshire the greatest Dealers have already laid down the Trade and are dayly drawing in their vast Stocks; and if there be not a way found out to encourage that Manufacture ere long we shall be all undone."

Trav. "If things in the Iron Concern are as you say the whole Country suffers much by it."

Iron. "They do so, For the Wood falls price, Labourers and Teems are unemployed and the Rents of the Land falls, the poor for want of Imploy many already are upon the parish and many more will unavoidably follow the same fate, and I am sure that the poor will live with the Rich ere long if the matter be not inspected and some Relief given and that in time too."

Trav. "Pray Friend, What do you think is the true reason that there should be so great a decay and lessening of the Iron Imploy; your Iron of the Forrest of Dean being accounted the Best and Profitablest Iron in England."

Iron. "Truly Sir, I hear by our Iron Masters, that the grand reason is, Because Iron of late dayes is brought so cheap into England out of Swedeland, Germany and France,

that at this time Swedish Iron may be bought for Thirteen pounds the tunn, and French Rods slit to make Nails, I saw sold at London before the prohibition, for Fifteen pounds the Tunn. And they told me, these Rods came out of that part of Spain, which the French had newly conquered, called Rosolion. And I wish our English-men had been asleep when they went to help the French King against the poor Spaniards."

Trav. "If these are the true reasons, which you here lay down, the matter may be quickly cured, and the Trade preserved."

Iron. "Sir, I know they are the Reasons: for you may be easily convinced that the Forreign Iron being so Cheap, people make of it to convert into several Commodities; and so, lessens the making of our own Iron; But pray Sir, which way may we be relieved and put into the Condition we were in twenty years since?"

Trav. "Friend, If you can satisfy me in two or three things which stick much with me at present, I will not only satisfy you how you shall bring your Iron Trade to the Condition it was in as to profit and Imploying the poor, but I will also shew you how (in particular) you Iron Miners in the Forest of Dean, may make a far larger and gainfuller Trade there, than ever heretofore don."

Iron. "Pray Sir, let me know your scruples, and I will give you as pertinent Answers as my weak Capacity will enable me."

Trav. "Friend, first I have heard, men not of the meanest rank (nor of least interest in England), say, That it was better with us, when we had no iron made in England, as also that the Iron Works had destroyed most of the Timber in the Kingdom. And I have heard these two reasons (backt with such Arguments) that I had little to say in the Negative."

Iron. "Sir, If you will please to have a little patience, and allow me my own way and method, I will make it clearly Appear; First, That Iron was made in England a thousand years since, And Secondly, That the Iron Works have been

(and now are) the Increase of Timber in most parts of England."

Trav. "Truly, Friend, if you can do as you say, I will not only shew you your Relief and Interest of the Iron Trade, but I will also shew this friend (the Cornish Miner), how the Tinn in Cornwal may in great quantities be employ'd in Conjunction with the Iron made of the Cinders and Iron Stone made in the Forest of Dean."

Tinn. "I pray you (Fellow Sufferer) be free with the Traveller, and it may so happen that you and I, and many more poor men (that get their Livelihood out of the Bowels of the Earth), may be bettered by his Experiences."

Iron. "Well, Sir, As to make it clear to you that Iron was in England a thousand years since, is very evident by those great heaps of Cinders formerly made of Iron stone, they being the Offal (or Wast) thrown out of the foot blasts by the Romans, they then having no works to go by water, to drive Bellowes, but all by the foot blast; and at present great Oaks are growing upon the tops of these Cinder Heaps, and monies continually is found amongst these Cinders, but such as is found is all of the Roman Coyn, most of which monies is Copper; very little found (of late days) that is Silver; and this Offal of the foot blast (by the Romans then cast by) doth at present make the best and profitablest Iron in England, it being mixed with some Iron Stone of the Forest of Dean, and there hath been (and still is) vast quantities of this sort of Iron Cinders in the Counties of Monmouth, Hereford, and Gloucester, and about twenty eight years since. Mr. Yarranton found out a vast quantity of Roman Cinders (near the Walls of the City of Worcester) from whence (he and others) carries away many thousand tunns or loads, up the River of Severn, unto their Iron furnaces, to be melted down into Iron with a mixture of the Forest of Dean Iron Stone; and within one hundred yards of the Walls of the City of Worcester there was dug up one of the Hearths of the Roman Foot blasts, it being then firm and in Order and was seven foot deep in the Earth; and by the side of the work there was found a pot of Roman Coine, to the quantity

of a peck; some of which was presented to Sir William Dugdale and part thereof is now in the Kings Closet. By all which circumstances it clearly appears that the Romans made Iron in England, and as far up the River Severn as the City of Worcester, where (as yet) there are vast quantities remaining.

"And as to Clear it that Iron works are the cause of the Increase of Timber, I must in the first place Acknowledge, that the Ironworks have for about fifteen years last past been the Occasion of felling and cutting down many great Woods in the Counties of Monmouth, Gloucester, Hereford, Salop, Worcester, Stafford, and Darby, and in some other places that the Offall and Wast of the said Timber might be employ'd in making Charcoal for the use of the Iron works, And it is well known (by great numbers of men now living) that the timber so cut down was so Ancient that it was fit for little but Fire wood, and had most part thereof been Cut down an Hundred years before, it had been of much more use and Benefit to the Owners thereof, and the publick (then when Fell'd) and the Great Woods particularly in the Forest of Dean in Glocestershire, and in the Forest of Wyer in the Counties of Worcester and Salop, and many other places, being so cut down, have at present been the only Cause and means of giving the Advantage to the Owners and proprietor thereof, to inclose many thousand acres of Copises-Woods, wherein vast quantities of young timber is now preserved, and in a very few years will be fit and useful for all Imployes whatsoever, And if those great Old Woods had not been Cut and Grub'd up, there had been now nothing of value growing only some old Dotard Trees which on the contrary, there is now growing on the same Land good thrivable young Timber, with Noble Copises of Under Woods, which are (and will be) made of great use to the publick and Benefit to the Owners of Such Lands: And it is very Evident and Clear that if the Iron Works had not been in those places planted, there had been no timber in being at this time there; because the Owners of such Lands would have converted the same into Tillage and pasture, and now it is (by undeniable Demonstrations)

Obvious to all Gentlemen and others who have Copises Woods in and near the places afore mentioned, That if the Iron Works fall or are not encouraged, that thereby they may have Monies for their Woods, that in a short time there will be neither Timber nor Copises woods in most parts of England where Iron Works now are, but such Copises will be grub'd up and converted into Tillage and pasture, as of late (and now it is) practised in the Counties of Sussex and some parts of Surrey, where at present the Iron Works are most of them laid down, being not able to make Iron so cheap as it is now sold by persons Importing it from Forreign parts; The Detriment whereof is fatal to all persons in those parts by Falling of Rents, the poor Un-imploy'd and the Woods Grub'd up, as before specified; And as for the Woods now in Copises in the Counties of Gloucester, Worcester, Salop, Stafford, part of Warwick and Darbyshire, they must cease being Copises Woods if the Iron Masters will not give them monies for their Wood, it being not worth the Cutting down and bringing Home to their Houses for their Use, and the true Reason thereof is, Because in all these before named Counties, pit Coal is so Good, so Cheap, and so durable, that it Answers all useful ends better than if they had Copises Woods given them for nothing.

"And now Sir, I hope I have made it out to you (by undeniable Reason as also Fact) that the Ironworks in the Counties before mentioned have been the only means to clear the Land from the Old Dotard Trees, as also they now are the only cause and true means of raising these great quantities of Copises Woods and Timber at present growing therein, and without the use of these Iron works, it will prove of unavoidable necessity, these Coppice Woods will Cease and Consequently, there will be neither Wood nor Timber growing in these places, as at present it is in some parts of Sussex."

Trav. "Truely friend, your Reasons have some weight with me and I have seriously considered of them, and as far as I can perceive, it is very fit and needful not only to give you the best Counsel I can for your relief, but to advise you to

make your Applications to Those in Authority, to look to it in time."

Iron. "Sir, I thank you for your kind Acceptance of my mean Reasons, but I will shew you a Chain of Miseries that will attend us and the publick also, if we have not some speedy relief: For it is worth the knowing (before it is too late) (what vast number of people) (of all sorts) are imployed in the Iron concern in the several Counties named; which I believe are not so few as One hundred thousand; And the great Riches these Manufacturing people bring to the Inhabitants near them, by peopling the place, Raising the Rents of Lands, and making of the Minerals (both of Iron-stone, pit-coal and Wood) all valuable both to the Rich and Poor of these parts, And if the Iron works are but two or three years neglected (they being fixt upon Great Rivers and Streams) will wholly decay, and the Workmen disperst, and gon to seek employ in other Nations. And then if an unexpected Sea War should break out betwixt us and any of our potent Neighbours and the Sound lockt up, we should then be in a Sweet pickle for want of such Iron Materials which are for present use: For, few men Consider how many Hundred Tuns of Iron Bullets are let flie in one Brisk Sea Fight in a large Fleet and against a powerful Enemy."

Trav. "Friend, I am now satisfied that the reasons for incouraging of the Ironworks are good, and unless Relief be quickly administred the Miseries you propose will certainly ensue, and the Consequence thereof may be fatal both to the people and the publick. But your cure is very easie and at hand, and the way is To Petition the Parliament; That they will lay four pounds per Tun of all Bar Iron imported, And six pound per Tun of all Imported Iron Rods, And three pounds per Tun upon all Raw Iron Imported."

Iron. "Certainly you have now hit the cure, and that which may be done with much ease: For many of the Parliament-Men are Concerned as to Woods, Iron Stone, and Coal: and they know, If the Iron Works fall, They (and the rest of the Nation) must keep the poor, which may prove to be a vast number."

Cor. "Sir, I find you have applyed a sufficient Remedy unto my Brother (the Iron Miner) whereby that Trade may flourish and increase as formerly: but I can assure you, I can acquaint you (and make it out), that we (the Tin Miners of Cornwal) are in a worse Condition than the Iron Miners and Iron Masters; and our Number is no less than Sixty thousand that depends upon the Tin Concern."

Trav. "Friend, forbear until I have had a little more converse with this Iron Miner, and then I will hear your Complaint and Grievances; for I must put my Iron Miner into a way and method to make cheaper Iron than made formerly; and you know, Cheapness and Goodness will carry all before it. And (my Cornish Friend), you may fall under the same circumstances, and, its possible, have the like benefit (or better), than my Iron Miner can; your case (I know) will fit my purpose better than his."

Iron. "Sir, What you have proposed for our Benefit already I have considered of; and I know that will give us (and our Masters) ample relief; but better is better."

Trav. "Friend, I know that monies at all times to be had (and at easy Rates) is the life of Trade; and the want of monies (when a Bargain offers itself, or to keep a man's Credit) may be of great Detriment to him. And I know that you Iron Miners, and your Masters, many times stand in need of, and want great sums of monies to pay for wood, and workmen's wages, and the reason thereof is, That when the waters are plentiful, and in the winter time, then you make great quantities of iron, and lay it up in the store-houses, but cannot carry it out into the Country to sell because of the unseasonableness of the time, and badness of the wayes, and thereby you contract many debts, and your Credits sink, and your Trade lessens, whereas, if you could do with the Iron as the King of Swedeland doth with his Iron and Copper, you would never want monies to supply your lawful Occasions, for the Swede will send into the Lumber House at Hamburge (any time when he pleases) Fifty thousand pounds' worth of Iron and Copper, and take away with him Forty thousand pounds of Bank Dollars; and

when the markets are good, give order for its sale, and receive the overplus, and pay but Three in the hundred Interest for the Loan."

Iron. "Sir, If this could be brought to pass here in England, I could drive a better and more profitable Trade (with half the stock) than now I am able to do, and my Credit would advance, and I should never want monies; for our Iron would be the best Pawn in the world, being Unperishable."

Trav. "Sir, this small thing to bring that to pass is no more than to have a Lumber House Erected by Act of Parliament, in all Convenient places, to receive in Iron in the Nature of a pawn, by these Words, or such like:

> "'BE it Enacted by the King's Most Excellent Majesty, &c., That there shall be a Lumber House Erected at for the Receiving in of all Iron by way of Pawn at Four Pounds per Cent.; and that all Iron so delivered, shall be transferrible Credit for Borrowing of Monyes, And that no Statute, or Law whatsoever, shall any way affect the said Iron, but that it shall be held Valid, and Good to the party owning the same, and to his Assignes.'"

Iron. "Sir, Now I thank you twenty times for this Notice of a Lumber House, and the imposition upon Foreign Iron: I will have them both put into a Bill, and present them to our Parliament men, for these two things will infallibly do our business and increase our Trade, and supply the Country with monies for all their Commodities and the Gentlemens Rents kept from declining."

Trav. "Now friend (my Cornish Chofe), I know you have something to say about the Concerns in the Tinn affair; but you being far from London I hope nothing of the Smell of any Court Monopoly hath Rackt you."

Cor. "Truly, Sir, I think We, the Miners in Cornwall, are in as bad a Condition, if not worse, than the Miners for Iron; for at present the Rates of our Tinn is so low, that it

will not bring us above Three pounds the Hundred, wheras we usually have sold for Four pound ten shillings, and five pounds the hundredweight; And our distress is also so great, that some times we and our Families are in want of sustenance, and food for our Bodies, notwithstanding we have a right and a Legal property unto considerable quantities of Tinn."

Trav. "Surely, if you have your Tin smelted and above ground, you cannot want Monies or Credit to drive your Trade, and have all manner of provisions at the best Hand for your selves and families."

Cor. "Sir, I wish it were as you say, or could be by any means made so; for the truth of our case is thus: We cannot sell, or dispose of any Tinn until it be Coin'd, and we have not above two Coinages a year; and there is such shuffling and dealings betwixt some men that have been late in Great power, and others of our Country, with some Merchants in London, that it makes our Commodity of no value, and we the poor labourers very miserable, and the Mine lye Unwrought for want of Monies or Credits (Equivalent to Monies) to pay Workmen and maintain our Families."

Trav. "Friend, speak out, and let me know the Particulars of the Action of these men you mention that spoil your Trade."

Cor. "Truly Sir, I dare not; for they have so linkt themselves together, that if I should offend one of them, all the rest will be my Enemies, and then I and my family may starve."

Trav. "Friend, I see your case is worse than the Iron Miners, therefore I will give you my advice freely, which is your way to get Relief. The want of Monies or Credit to drive your Trades at all times and seasons, is the Misery you now groan under, and consequently will be a great detriment to the whole Country; therefore by Act of Parliament procure your Coynage to be six times a year. And in the same Act let there be a Lumber House, as is directed in the case of the Iron Miner, to take in the Tin by way of pawn; and also a Bank Grannery to take in Corn and

Malt, when cheap for Food for your Miners and all those that depend upon that Imploy, and then you shall never want Monies so long as you have Tin to deposite in the Lumber House, nor, its possible, eat dear Bread, or drink dear Drink, during your lives: And alwayes your Corn in Bank Grannary will be to you sufficient Credit to borrow Monyes upon, and at small interest; this way will cause all your Oppressers to vanish upon a sudden, and all the Monies then with you unimployed in the hands of all manner of people, will tumble into the Lumber House and Registered Banck Granery, and you then will be in a capacity to keep your Tin till you may stay to the best Market, and then you will alwayes be augmenting your stock, but now you are running into poverty and Confusion."

Cor. "Sir, I have seen this method of Lumber houses and Banck-Graneries, whereby Cheap Bread and Cheap Drink may be to all the Mechanicks of England, and Credit or Monies Equivalent upon Commodities delivered into the Lumber House, printed in a Book called Englands Improvements by Sea and Land, And all our Country Echoes to it that way, and I believe If we were fixt well by that method we should be the only County of England for Riches and Strength."

Trav. "Friend, you are best posted of any County of England as to Importation and Exportation for the Seas: God and Nature hath fitted you with two of the most Eminentest and profitablest Commodities in this Kingdom. The one is your Tin which lies in the Bowels of your Land, the other is the Fishery of the Pilchard that so seasonably and constantly visits your Coasts, but whose Exportations are, from you, Shipt off with more advantage then from any other County in England, you having Harbours to Ship off towards the West for to Answer Ireland, the Great River Severn, the West Indies, and up on your East Coast sufficient Harbours for to answer your ends for France, Spain, the East Indies, Mediterranean and the Baltick. And honest Miner, I tell thee God and Nature hath so posted you, that nothing in this Kingdom is comparable to it: get

but this publick Credit here held out to you, and your business is done: away flies your new oppressors, and Lawyers may then ride fix on a Horse; for you will have Credit to pay your just Debts; And as for the Aparitor he will be muzled, for he is a Cunning Knave and knows very well whose Errand he hath gon on this twenty years."

Cor. "Sir, I will acquaint all my Fellow Miners of this Relief that may (I think) be with ease obtained, and will meet you at Bristol Fayr, where we will consider further of the matter, and then to get the Parliament to be so kind to us, to pass such a Bill as you shall advise, And so farewell for this time."

Trav. "Hold, Friend, I have something more to say in Conjunction with you and my friend the Iron Miner, wherein I hope I shall make it out, that I shall put you both, and all your Miners (with the two Counties of Cornwal and Gloucester) to fall upon a new Manufacture, the Foundation whereof must be of the minerals, And thereby give you a further Relief than what is already proposed to you."

Cor. "Sir, I pray, let's have all; for I find you minde the Good of the Poor, and those in Distress."

Trav. "Friend, There is a Commodity made in the Mountaines of Friburg in Saxony, called Tin-plates, the ground of which is Iron, and Tinnd over; And in that place there are all the plates made that are at present use in the known world; and the Trade is there so great that by computation, no less than Eighty thousand Men depend upon it in preparing and digging Iron-Stone to make the plates; digging Tin mine, to Tin the plates, when fitted and made ready, Cutters of Wood, Colliers, Carriers and Workmen of all Sorts; And those plates are (when fitted) sent by Land to Lipsick, from thence by Land to the Elbe River, and so down to Hamburg, and from thence sent by Sea as far as Trade is known."

Cor. "But Sir, I pray what is the Goodness and Cheapness of their iron there, and also of their Tinn and Charcoal? For it is Cheapness and Goodness in all Commodities that gives it settlement."

Trav. "Friend, you say well, it is so; And I will let you know the truth of those Enquiries you make (it being my fortune to be in the Company of those persons that were imployed to get away the Art) as to the Iron; It was worth Sixteen pounds per Tun when I was there, and the German Tin was worth Five pounds the Hundred weight, and the Charcoal was worth Fifteen shillings the Load; some of the German Iron (and some of their Tin) is in London; And upon proof it appears, English Tin is much better than the German Tin; And that the Iron in the Forest of Dean is much better than the German Iron, and may be made much Cheaper than theirs can."

Cor. "Sir, it is a great pitty, but that some Trial might with speed be made to find out how our English Iron and Tin would work into those plates and thereby we may make some probable Conjecture of the success of so noble undertaking as that may prove."

Trav. "Friend, There hath a late Trial been made already, and many thousand plates made of the Forest of Dean Iron, and tind over with Cornish Tin, and the plates proved far better than the German plates, and would work into many and Sundry sorts of utensils and useful things, for the benefit of the publick, which the German plates would nor can do, the true reason whereof was the toughness and Flectibleness of our Forest Iron."

Cor. "I wish I could see some of the plates and know any of the persons that workt up any of the plates made of English Iron and English Tin into useful Vessels."

Trav. "I will befriend you so far; One Mr. Dison (a Tin-man in Worcester) hath wrought up many; one Mr. Lydiate, near Fleet Bridge, hath wrought many; And one Mr. Harrison near the Kings Bench in Southwark hath wrought many; and from those men you may know the goodness of the Metal, and the value may be put upon those plates, above those at present fetcht from Germany.

Iron. "Sir, I like this new Manufacture very well, for it will enlarge our Iron Trade, and I am satisfied it will consume great quantities of Wood. But then, as it helps us

one way, it will prejudice us another by Inhancing the Rates of Wood, and when the Trade is well settled and in a thriving way, then some observing Traveller or other may discover where Wood, Victuals, and Land may be had Cheaper than with us, where it was first fixt, and so remove and carry away the Trade, after men have been at great Charge in the fixing thereof, for Employs and Trades remove from place to place, according as they are fitted and accommodated with Convenient places, and Cheap materials to work upon, with cheap Victuals of all sorts for the Workman imployed therein."

Trav. "Friend, Now I find you mind your own interest and the true interest of the publick; and what you say Cheapness and Goodness doth and will govern all Trade; therefore I know a place so conveniently fitted with Rivers to set up Works with vast quantities of Woods not to be exhausted, and so Cheap that no Man can desire it to be Cheaper and it is on both sides the River Slane in Ireland, and about six miles above Eniscorthy, and from the Forest of Dean the Cinders and Ironstone will be carried to Eniscorthy up the River Slane for Ten shillings the Tun; and the Barks may take back to Bristol Barrel Staves, and Shipping Timber, and from Cornwall Tinn may be sent by Sea to Eniscorthy for ten shillings the tun; and the Barks may bring back to Cornwal Charcoal from Ireland to help to smelt down the Tinn and thereby preserve the little wood you have, and the labour of sending your vessells to Red Bridge in Hampshire for Charcoal, as now used."

Cor. "Now Brother Iron Miner, I am truly satisfied that this our Traveller saith, may with ease be brought to pass, and Answer all your and my Ends; for I have been in these Woods mentioned and the greatest part thereof lies Rotting; and this I know, wood may be had there for sixpence a Cord, and there are good Rivers to set up the Work upon, and cheap Victuals to feed the Labourers."

Iron. "Truly, I must now Recount the infinite Benefits that This new Design of making Tinn-plates may have to all persons concerned, and the publick.

"First. It will Rob a Forrain prince of a great Staple Manufacture and save our Monies at home, so largely sent out to by these plates.

"Secondly. It will give us a vast Exported Trade, and all made of our own minerals and by our own Natives.

"Thirdly. It will give life and Courage, and enlarge the Iron and the Tinn Trade.

"Fourthly. It will employ great numbers of Ships to carry over into Ireland the Iron stone and Cinders out of the Forest of Dean, to make Iron to be converted into plates, and Tinn from Cornwall, and many Vessels and Ships will be employ'd to Transport the plates (when made) into all parts as far as Trade is known.

"Fifthly. This new Trade will so people and enrich that part of Wexford and Wicklow, where these unemployed, wasting, rotting Woods now are; that the Riches obtained thereby, and the multitude of Manufacturing people, may chance to be a bulwark in preserving the peace of Ireland on that quarter, those places being always most pestred with the Toryes."

Trav. "Friend, Peter Heylin in his Geography tells us that there was no Tin in Europe, but in England, before it was found out by a Cornish man near Newrinburg in Germany, and he saith that the Tin-plates are made near Newrinburg, but in both he was mistaken: for, the Cornish man found the Tin in the Mountains of Fryburg in Saxony, near a Town called Awe, where his Statue is yet to be seen, and the Tin works lie all in a Valley from Seger Hutton down to Awe, being a Tract of Ground about twenty miles in length, and they are fixt upon a great River runing down the Valley, and the Tin, Iron and Woods grow in and upon the Mountaines adjoining to both sides the River; and those Tin works have proved so beneficial to the place, that there are several brave Cities Raised by the Riches proceeding therefrom; they being the City of Anaburge, the City of Sneburge, the City of Mareanburg and many others; and for people and riches in that barren Mountainous Country they do as far surpass the rest of Saxony, as

Burmingham in Warwickshire and thereabouts doth Leicestershire for people and Riches."

Iron. "Sir, It is pitty that our Iron mine should lie in the earth untoucht, and the Tin Cornwal lie in heaps and no benefit made of it, and the Woods in Ireland lie rotting; and so noble and brave a design as this, should so long lie obscur'd, and no Improvement made on those things for the general good of the publick and mankind."

Tin. "Friend, I question not, (Now it is discovered) but it will in some short time be taken into consideration, and men in power and of Estates, will use all lawful wayes and meanes to bring the business into method and order, because it is their own interest."

Trav. "Friend, be not too hasty: All things of this kind must have their Seasons, and the Times and People (then in being) must be addicted to Improvement and good husbandry."

Iron. "I pray Sir, how came the Duke of Saxony to have this great Improvement fixt in his Territories and to be Master at this Time of all the Tin-plates that serve the whole World."

Trav. "The Trade of making these plates was about sixty years since fixt in Bohemia, and had there long continued, but the Woods decaying, and Fetching their Tinn from Saxony; and (when the plates were made) a Long Land Carriage was necessitated to be performed, before they could bring the plates when made either unto the River Elbe, or to the River Rinne, which did much enhaunce the price of the Commodity; and there being at that time a wise Duke of Saxony, and one willing and ready to improve his own Revenue and his Subjects, (did, as its Credibly related,) where the plates are now made, Accept of a method and Directions how this trade might be fought away from the place it was then fixt, and be settled in the Duke of Saxony's Territories; A Romish priest converted to be a Lutheran was the Chief Instrument in the whole affair, untill perfected: and a Cornish miner Banisht out of England for Religion, found out the Firm in Saxony: both which persons

proved Instruments of great Wealth to that Duke and Country."

Iron. "Sir, I find there are undeniable methods to Imploy infinite numbers of people in the improving our own minerals, and bringing them into Manufactures; and you give sufficient instances, and also shew us, that a Reformed Roman priest and a persecuted Protestant, were the Chief Agents of bringing this great Trade, and fixing it in Saxony. I would we could find how to imploy, or improve our poor Clergymen, and have some honest and good imploy for them, that they might not turn papists, and that some care may be taken that learning as people call it, may not be a burden to the Nation."

Cor. "Truly Sir, you say well, and I think it is advisable (as things stand) to have some particular inspection into that affair, and the Improvement of those men, if possible, may be well imployed. For I am Credibly informed that there are (at present) Thirty thousand in Episcopal Orders: and its said that there are not above Ten thousand Livings in England, and its possible there may be Ten thousand poorly Imploy'd, in being Chaplains to Noblemen and others, as also School Masters and Curates."

Iron. "Friend, I see the persons are under worse circumstances than Thee and I are: for here are (by the Computation) Ten thousand to be Provided For: I swear I am glad that we have some fellow sufferers; for in our Country we say the more the Merryer, I hope there are no more supplies to be sent from the Universities and Free Schools until these Supernumerary priests are provided for, and well fixt in a comfortable way: for if these sort of people be not, they will spoile all, for they will be doing good or hurt, Schollars will try to Improve their Skill and Learning."

Cor. "Truly Friend, the case of the young Clergyman of England is sad and to be pittied; and its happy they have done no more mischief to the people and themselves at this day; For the old saying is, in our Country, Hunger will brake Stone Walls.

Iron. "Sir, I know not what mischief possible, a great

part of them could do more than they have done for some years past, some its true, preach well, and invite the people to a Holy Life and Reformation of Manners; but others more dignified, shoot their keen arrows, which stick hard in the sides of those that profess the same Faith with them; and its possible, (it may with Ease be proved) that those arrows came out of Popish Quivers.

Cor. "Truly I was amazed, when I came into Company with many of our Country priests, at the time when we were thinking of petitioning the King for the Sitting of the Parliament, O how they did splutter, and cry out against us, called us Fanaticks: and sometimes said it was the fore runner of Rebellion, and generally would speak slitely of Doctor Oats, Who discovered the Popish Plot: and let drive against the Presbyterians and give out large hints, that there was a Presbyterian Plot."

Iron. "Sir, If you read Mr. Dangerfield's Narrative, commonly called the Meal Tub Plot, concerning the Presbyterian Sham Plot, you will perceive how that meer Schollers were mistaken, and Trapan'd by those subtle accursed Jesuits that have so long been carrying on the Destruction of our Religion, and property; For (saith he) I was Imployed by Madam Pours and Mrs. Cellior, (the popish Midwife) to go to Petterly in Buckinghamshire, to the House of Mr. Webb there to take instructions from one Madam Jane, how to manage the Sham Presbyterian Plot; but saith he this Madam Jane proved to be a Romish priest, from whom he received, (as he swears) Instructions to employ persons to write and spread Pamphlets signifying a Presbyterian Plot; and to put numbers of persons (in several Coffee Houses) to blow up the people into an Opinion, that it was really so; upon which many, of our Debaucht Protestants immediately Ecco'd; and some, who called themselves Church of England men, would often say, They had rather be Papists than Presbyterians; And in this heat, and Nick of Time, one Hickeringbil a Minister, preacht before the Lord Mayor to Incite the Governors to use the Dissenting protestants not very kindly, And not long after him, a

worthy Divine (none of the least in Dignities and Spiritual promotions) in the same place, preacht a Sermon, not much better, which was answered by several Dissenting Protestant Divines. And upon this heat, the poor ignorant Small Priests in Coffee Houses and elsewhere and sometimes in the pulpit, Blew up the Credilous, into an opinion it was really a Presbyterian; but you may forgive them this one time; for I believe, they will never be able to do the like again."

Cor. "But Sir, It is strange to me, that the arrow then shot out of the Jesuits Bow, should drop into the Little Episcopal Mans quiver, because the popish plot was discovered, half a year before that time; and certainly if popery had crept in, those men could not rationally think, nor the Bishops neither, that they should have continued in their Fat Livings."

Trav. "Sir, you must know that Drowning men will lay hold on every twig; for I have known the Universities (both Oxford and Cambridge) long, and I have been an Observer of the Schollers, and their wayes and method to gain and keep their preferments. In the year 1637 Doct. Prideux was Doctor of the Chair at Oxford, then they at Oxford were under the Episcopal Oath. In the year 1646, Doctor Rainals (that died Bishop of Norwich) was a Governor there; then it was the Covenant, and about many went to keep their preferment. In the year 1651 Doctor Owen was a Governor there; then it was the Ingagement, which was against King and House of Lords, and about they went again. In the year 1669, Doctor Bell, the present Bishop of Oxford, was a Governor there, and then it was the Episcopal Oath again, and about again: And for saving of their Livings and preferments, not only those of the Universities, but multitudes of the Clergymen in this Kingdom run through all these tests and engagements. And if you will read Baker's Chronicle, page 351, There he tells you that, in the alteration of Religion between Queen Mary and Queen Elizabeth, of the Nine thousand odd Hundred parishes in England, there were Nine thousand of the priests Alter'd

their Religion with the Queen; only the odd Hundreds non Conformed, and when the Bishops were restored, after the King's restauration, they imposed upon the Ministers, to engage to obey their Ordinary in all things; and if at any time they Neglected or refused to put the Bishop's Chancellor's orders in Execution (notwithstanding it was contrary unto the Laws of the Land), presently the poor priest is suspended; and at this day it is constantly practised by the Lay Chancellor to Excommunicate men for small and trivial things, and never acquaint the Minister thereof, until the Excommunication comes into his hands to be published. So the power of the Keyes is handed (and banded) about betwixt the Lay Chancellor, Register, Surrogates and Apparitors; and the poor people shorn and fleec't, and the rich priest slighted and concern'd by his parishioners, he having no power allowed him to endeavour the Reformation of his peoples Lives, or Amendment of their Manners, but only, forsooth, what the Lay Chancellor pleases; the cause whereof hath brought the Ministers into contempt, a general debauchery of the people through the whole Nation; And in most places it is at this day, like parson, like people."

Cor. "Sir, there is reason why the Lay Chancellor and Register should get what monies they can of the people. For they have in some Diocesses paid the Bishops dear for their places, and the Old Saying is, He that buyes dear must sell Dear, and he that purchaseth the Devil, may Sell his Skin, or else he may chance to lose by the bargain."

Iron. "Come, pray let us find out a way to Restore these Supernumerary Clergymen and prevent any more Swarmes of them, until these are comfortably provided for. For I see now they are in a far worse case above ground, and have mistaken their own interest and their Nations, more than we Tinn Miners and Iron Miners have done ours; although our Trade and Work is altogether under ground.

Trav. "We will admit what you say is true, that there are Ten thousand Clergy Men, Unprovided For, and at present there is no Imploy for them, Truly it is a pitty that learning should be a burden to a Nation, and the gifts of

pious and well meaning men should not be better imployed, but in this case there is a great Error in State, for these persons are bred as Gentlemen, and some in their Education have Cost their parents Two, Three, or Four hundred pounds apiece, and all to no purpose, or to very little, for here in this Case, the Father hath lost a Child (The Gentleman) nothing to trust to and the King hath lost a Subject; The Church full! So God wants them not, and man wants them not, because they must not be imploy'd out of their Calling. But that which is worst of all, the Universities are full of Students, and the Free Schooles all England over are full of Schollers; and what this will come to at last, a man (half out of his Wits) may easily guess at."

Cor. "I understand, by Discourse with Travellers, that there is no Reformed Church, that suffers any man to be made a priest until he is twenty-eight years old, and generally he is twelve months probationer before he is fixt with the people where he is to be setled. And if such a Law were made with us, for such as intend the Ministry, every ordinary Tradesman, and Mechanick, would not send his Son to the Universities; for the Charge would be so great (in that length of time), that none would be sent thither for that purpose, but such whose parents are able to maintain them; and who really intend their Children to be there supported for the true ends the Universities were Designed for; and then all those poor, simple little Tools, made priests out of the Sirvitors and poor men's children, that are now imploy'd to be Journey Men to the Rivialist would quickly vanish. As also, that the great pluralists may drop to others (its possible as well deserving as themselves) some of their Fat Livings."

Iron. "Now I am satisfied that we shall be provided for, and Improve our Iron, our Tynn, our Irish Wood, both the Universities and all the Young Clergymen. And I find all this may be done by an Act of Parliament of Twenty Lines, and no man Damnify'd, but all Bettered. Well, let the World say what they please, I am seriously affected for These Improvements."

CHAPTER XII.

LOCAL NOTES—MONMOUTHSHIRE IRONWORKS IN 1810—PONTYPOOL WORKS STARTED, 1588—PONTYPOOL JAPAN WARE—HISTORY OF THE HANBURY FAMILY—NEATH IN 1798—YNIS Y GERWN TIN WORKS—NEATH ABBEY, A.D., 1500—CAERLEON IN THE TIME OF THE ROMANS—CAERLEON TIN WORKS—STORY OF CAERLEON BRIDGE—CAERMARTHENSHIRE AND GLAMORGANSHIRE IN 1805.

SPREADING out from Pontypool, towards the end of the last century, we find Tin-plate works started in Wales, almost wherever the old-fashioned water-power forges existed for the manufacture of charcoal iron. This affair being taken up as an *addition* to existing business, the trade followed the mountain streams, as it formerly doubtless did in Bohemia; the new method of expanding or rolling the bar iron into sheets contributing more than anything else to its success.

The Welsh mountain torrents are thus observed upon by the Rev. Richard Warner, of Bath, in a description of his 'Walk through Wales,' 1798. "A mountain torrent, like the woman of a certain Greek philosopher, is all impetuous rage, or all insipid tameness. A storm of a few hours excites it to fury; its passion, however, is but transient, and as short a portion of fine weather lulls it again to repose.

Excepting only those of Pontypool and Caerleon, there is no exact record of when or by whom the several works were started; but casual reference may be found to the subject in gazetteers and books of travel: and in the hope that it may be interesting to those more particularly associated with South Wales, I now propose to give in detail a little local information which is to be found connected with the several towns where such works were situated.

MONMOUTHSHIRE.

[*Extract from 'Beauties of England and Wales.' By Rev. J. Evans, and J. Britton*, 1810.]

Till lately Monmouthshire was not ranked among the manufacturing counties, and that it is so at present has arisen from the rich mines of Iron and Coal with which it everywhere abounds.

The Iron Works are the boast and certainly, in every point of view, the most important objects of trading considerations in Monmouthshire. The attention of the county, in respect to the modern history of the Arts, was first excited to this lucrative branch of manufacture in the reign of Queen Elizabeth, an era no less celebrated for its political economy than its military and diplomatic glory. From that period, considered by many the time of its origin, the iron business of this district, and in the adjacent county of Glamorganshire, made a rapid progress, and much surprise has been expressed why it should have been so long neglected. This surprise, indeed, may almost arise into wonder, when it is recollected that iron was manufactured in this part of the island at an epoch beyond the reach of history. Large heaps of cinders or slag have often been discovered, evidently the refuse of Roman or British bloomeries, the process in which was the ancient method of fusing iron. In other places have been traced the sites of forges long disused, of which no account of their foundations can be collected but from tradition.

These cinders and furnaces afforded sufficient proof of the assumption that the iron mines were turned to good account at an early period, but the fact is further corroborated by numerous names allusive to woods and forests in places where no trees at present grow, and is still further ascertained by the discovery of trunks and branches of large trees, with their leaves embalmed as it were, under the boggy soil in the vicinity of Blaenavon.

The iron trade again declined, after its revival in the time of Elizabeth, from a variety of causes. The troubles in the

reign of Charles the First, and the changes which took place in point of property, occasioned an alteration in the genius of the people; agriculture was more attended to, the lands were cleared, the forests were neglected, and the numerous herds of goats, formerly kept in this part of the country, tended to destroy the woods, which were essential to supply the necessary fuel for the forges, so that for a considerable period little or no iron was wrought.

About 1770 a sudden renewal of the works took place, occasioned by the discovery that pit coal would form a useful substitute for charcoal in the making of pig iron, and its utility was further extended to the manufacturing of bar iron.

The local advantages of this county in these respects are peculiarly great, as the district abounds in iron ore, coal, lime, numerous streams of water, and every requisite proper for this branch of business. These have been powerfully aided by the mechanical powers, the use of the steam engine, the improvement in hydraulic machinery, and the adoption of rollers instead of forge hammers, called the puddling process, by which bar iron is formed with a degree of despatch and exactness previously unknown. From this concurrence of circumstances the success has been no less rapid than extraordinary. In 1795 the weekly quantity of pig iron made in this part of Monmouthshire, and in the contiguous district of Glamorganshire did not exceed 60 tons; at present it scarcely falls short of 600: at that period, no bar iron was manufactured; but now the quantity amounts weekly to more than 300 tons. The works are still rapidly increasing in extent and importance, and appear likely to surpass the other iron manufactories throughout the kingdom. Their extent and importance may be estimated from the subjoined list.

A List of Principal Iron Manufactories.

Sorwy	Pit-coal furnace . .	Monkhouse & Co.
Ebwy	Pit-coal furnace . .	Harford, Partridge & Co.
Nant-y-Glo . .	Pit-coal two furnaces .	Hill, Harford & Co.
Blaenavon . . .	Pit-coal three furnaces	J. Hill & Co.
Abercarne . . .	Pit-coal forge, and charcoal wire-works, and charcoal furnace . .	S. Glover, Esq.

A List of Principal Iron Manufactories.—*Continued.*

Machen . . .	Charcoal forges. . .	Harford, Partridge & Co.
Gelliwasted . .	„ „ . . .	„ „ „
Bassaleg . . .	„ „ . . .	„ „ „
Caerleon . . .	„ „ . . .	„ „ „
Pontypool . . .	Charcoal furnace and forges	C. Leigh, Esq.
„ . . .	Two pit-coal furnaces	
Lansilio on Monnow	Charcoal forge	
Trostrey . . .	Charcoal forges . . .	Harvey, Wason & Co.
Monmouth . . .	„ „ . . .	Harford, Partridge & Co.
Tintern Abbey . .	Charcoal furnace forges and wire works . .	Mr. Thompson.
Rogeston . . .	Tin mills	J. Butler, Esq.
Caerleon . . .	Large tin works . .	„ „

[*Extract from David Williams' 'Monmouthshire,'* 1796.]

The celebrated Manufactory of Pontypool preserves its reputation, and is continued in the family which first introduced it.

But no disposition appears in the natives of the district to adopt the habits of manufactories.

To the philosophical traveller this is not a subject of regret; for the peasant, to persons who will be at the trouble of adopting his language, is more intelligent and more amiable than the artificer: the former has had his mind unfolded on various subjects; the latter is a machine unfeeling, immoral, and unpleasing.

Manufactories, however they may add to the public wealth, certainly degrade and brutalize the people; and managed as they are on principles of monopoly, a species of slavery is their constant effect.

Children brought up as machines are depraved in body and in mind, and mechanics substituting intemperance for domestic comforts, are bad husbands, bad fathers, and corrupt or unprincipled citizens.

The pleasure of visiting these hills and contemplating the vast preparations for circulating their wealth is not, therefore, unmingled with sorrow.

During the century which has created the large and

populous towns of Liverpool, Manchester, and Birmingham, hardly any movements have taken place on the noble rivers the Usk and the Wye.

Exceptions to this reprehensible negligence will probably become the occasions of the general prosperity of the county. The first of those exceptions, in importance as in the order of time, is to be found at Pontypool. Coal works and manufactories of iron, usefully employing in Great Britain more than a million of persons, have been principally confined, in this county, to the family of Hanbury.

Capel Hanbury, descended from an ancient house in Worcestershire, is the earliest proprietor on record of the iron works at Pontypool. The first period, in books of accompt, is in 1588; and the first date of a conveyance of lands, purchased by Capel Hanbury is in 1665.

The ancient mode of making bar iron in bloomeries was then probably in use, by which malleable iron was produced from the ore, by one operation, and by one fire.

Capel was succeeded by his son John, generally known as Major Hanbury. In his time, the modern method of making iron by furnaces and fineries appears to have been fully in use; and it was extended by him not only in Monmouthshire, but in several adjoining counties.

To Major Hanbury the iron trade is indebted for several material improvements. The present mode of slitting and rolling iron, *and that of making tin-plates, were first introduced by him.* The extension of the works, and his numerous purchases of estates, are proofs of the great advantages derived from spirited and useful enterprises.

Pontypool Town.

[*Extract from Coxe's 'Historical Tour,'* 1801.]

The town principally owes its foundation and increase to the iron works established by the family of Hanbury; it is likewise remarkable for the Japan manufacture, known by the

name of Pontypool ware. In the reign of Charles II., Thomas Allgood, a native of Northamptonshire, came to Pontypool, and being a man of projecting genius, made various experiments to extract copperas and oil from coal, and finally invented the method of lackering iron plates with a brilliant varnish, in the same manner as the Japanese lackered wood, which was afterwards distinguished by the name of Pontypool ware. Dying, however, before it was brought to perfection, his son Edward, who inherited his father's genius as well as his father's secrets, pursued the discovery with increasing spirit, made considerable improvements, and finally established a manufactory of Japan ware which was long unrivalled. This manufactory is still carried on by his grandson William, but on a less extensive scale; its decrease is principally owing to the rise of similar establishments in other places, and particularly at Usk, under a branch of the family.

Edward Allgood was the principal agent of Major Hanbury, and assisted him in directing and improving the iron works, particularly the wire manufactory, which was deficient in the method of polishing to that established at Woburn in Bedfordshire. For the purpose of discovering the secret, Edward Allgood repaired to Woburn, in the character of a beggar, and acting the part of a buffoon gradually obtained access to the workshops, and was permitted to inspect the various processes, by which means he acquired the art of making the leys, the principal ingredient for giving a more brilliant polish to the iron wire, which was the only desideratum in the Pontypool works.

The situation of Pontypool near a region rich in mineral treasures, in the midst of forges and collieries and at the head of the canal, renders it peculiarly commodious for the establishment of iron manufactories, and perhaps another generation may see a new Birmingham start up in the wilds of Monmouthshire.

The Hanbury Family.

The family of Hanbury, to whom the town owes its consequence and celebrity, have long resided at Pontypool Park in the vicinity. Their ancestors were formerly seated at Hanbury Hall, in Worcestershire, from which place they derived their name, according to the red book of the bishopric of Worcester. Roger de Hanbury was born there in 1125, and his descendant Galfridus resided there in the middle of the sixteenth century. About the year 1500 the possessor disinherited his brothers, and left the seat and part of the estate to a natural daughter. Richard the eldest settled in London, and is distinguished as one of the Goldsmiths' Company (for so the bankers were called), in the reign of Henry VII. His eldest son, Capel, purchased an estate at Pontypool, and was the first founder of the iron works. The earliest conveyance deeds are dated 1565, and a regular account of the sale of iron commences in 1588. Neither he nor any of his immediate descendants were seated at Pontypool, but possessed landed property in the parish of Kidderminster, in the county of Worcester, where they seem to have resided. They occasionally repaired to Pontypool for the purpose of inspecting the iron works, and the initial letters of John and Richard, the son and grandson of Capel, together with the family arms, are carved on the pulpit of the church, with the date of 1637.

Capel, the son of Richard, died in 1704, and was buried in the chancel of Kidderminster Church under a flat sepulchral stone with this memorial:—

HERE WAS LAID THE BODY OF CAPEL HANBURY, ESQ.

MAY IT REST, AS HE LIVED AND DIED, IN PEACE, IN THE 79TH YEAR OF HIS AGE, 14TH JAN. 1704.

"With length of days he met his fate prepared,
No murmurs, not a sigh or groan was heard;
That peace that dwelt within his honest breast,
Has smooth'd his passage to eternal rest."

Neath.

The following account of the neighbourhood of Neath, and vivid description of the tin-plate manufacture as carried on in 1798, is taken from 'Walks through Wales' by the Rev. Richard Warner of Bath.

Leaving Knoll (the once celebrated but now neglected seat of the late Sir Robert Mackworth) on our right we pursued the canal, and at the distance of two miles from Neath, reached Aberdillis forge, the property of John Miers, Esq., where the crude or pig iron is formed into bars, and sent in that state to another forge belonging to the same gentleman further up the valley, called Ynis-y-gerwn, to be manufactured into tin-plates. A scene of great beauty shortly after occurred—the pleasing cascade at Aberdillis mill; the fall, indeed, is not so stupendous as some others in its neighbourhood, but certain little local circumstances render it very interesting.

In order to survey the scene to advantage it is necessary for the spectator to wade the river which flows from the fall and to plant himself under the opposite bank, since a huge rock covers, as it were, the front of the cascade, and prevents a sight of it from the road. A roaring torrent called the Dillis, flowing from the mountains, is now seen discharging itself through a rocky rent, darkened by the thickest shade down a perpendicular descent of forty feet. Near the point from whence it tumbles a rugged mis-shapen mass of stone receives it, and dividing its waters throws them out of their natural direction and creates two cataracts, which cross and intersect each other in a most whimsical manner.

The scene above is equally extraordinary, the river overshadowed with trees, has the appearance of issuing from an impenetrable wood, and rolls over a rocky laminated bed, consisting of ledges not unlike a vast irregular flight of steps.

A little further an artificial curiosity afforded us amusement—the tin-plate works at Ynis-y-gerwn. Here we contemplated with astonishment the operations of machines of

which before we had no idea, rollers of such immense power as reduced bars of iron two inches thick to the thickness of a crown piece by passing them a certain number of times through their revolving cylinders, and scissors cutting plates and bars in sunder of half an inch thick with the same ease that a fair sempstress would divide a wristband.

When, by the repeated pressures of the rollers, the plate is reduced to a sufficient thinness to receive the coating of tin, it is cut by the scissors into sheets of a proper size. These are scoured well with sand and immersed in an acid liquor, where they are suffered to remain some time, and then quickly and perfectly dried, a process pursued in order to clear them entirely from every speck of dust, the smallest particle of which would prevent the tin from adhering to the iron, as no metal will combine itself with any earth, and rust is nothing more than the earth of iron.

The plates thus cleaned are next plunged vertically into a pot containing melted tin, the surface of which is covered with pitch, suet, or some fatty substance to prevent the calcination of the tin, and to make the surface of the iron more inclined to receive its coating. By this immersion the tin immediately unites itself to the plates, and they are taken out completely tinned; being afterwards well rubbed with bran in order to give them a more brilliant appearance. They are packed in chests and sent to Neath to be shipped for the London, Liverpool, and Bristol markets.

NEATH ABBEY.

Translation of an Ode by Lewis Morganwg to Lleision, Abbot of Neath, circa A.D. 1500.

Everlasting courts of Lleision, Abbot of Neath; famed, insulated retreats. May a Golden Crown adorn His Head—true Son of Noun.

An Abbot the chief of every abbot; fruit of heavenly culture; fragrant as Jerome; of the sweetness of Augustine.

A goodly Churchman of divine mission; an apostle of the race of Testyn; a second Daniel; of the blood of Einion; the key of learning; another blessed Lleuddad.

The Temple of Neath with its many new-built dwellings: God is glorified in this Temple. He (Lleision) is another paternal Dunawd, an Abbot of ready answers, a Bernard. The Arbitrator of Religionists.

The Shepherd of the Faith; the support and staff of the Pastoral office, and the rod of Aaron; like balm to this Palace of Mary, as when the fulfilment of Simeon's blessing came to the Virgin's abode.

We now present to the Virgin a Petition, that the one God above, for the blood that flowed from his breast, intercede for a long life to Lleision; that there may be here sages of eminence, ardent men of learning, men of piety, humble and beneficent. May the protection of God be over this sanctuary of our language, holy and venerable amidst its verdant meadows.

Like the sky of the Vale of Ebron is the covering of this monastery; weighty is the lead that roofs this abode—the dark-blue canopy of the dwellings of the godly; every colour is seen in the crystal windows; every fair and high-wrought form beams forth through them like the rays of the sun—portals of radiant guardians?

Pure and empyreal. Here is every dignified language, and every well-skilled Preceptor. Here are seen the graceful robes of prelates; here may be found gold and jewels, the tribute of the wealthy.

Here also is the gold-adorned choir, the nave, the gilded tabernacle-work, the pinnacles worthy of the three fountains. Distinctly may be seen on the glass imperial arms, a ceiling resplendent with kingly bearings, and on the surrounding border the shields of princes; the arms of Neath of a hundred ages: there is the white freestone,—and the arms of the best men under the crown of Harry,—and the church walls of grey marble.

The vast and lofty roof is like the sparkling heavens on high: above are seen archangels' forms; the floor beneath is for the people of earth, all the tribes of Babel; for them it is wrought of variegated stone. The bells, the benedictions and the peaceful songs of praise, proclaim the frequent thanksgiving of the white monks.

Here, on the banks of the river, is a court resembling the Temple of Solomon, or the edifices of Rome. This monastery and court of Lleision is equal to those; and its priests more exalted than the Patriarch of India.

Never was there such a fabric of mortal erection, nor roofed wall, nor vast habitation; never was there such a foundation, nor splendid palace, nor oak of earthly growth; never was there and never will there be such workmanship in wood as this which will not perish while the day and the wave continue.

Here are the flowing streams of the grape, the animation of the multitudes; the three colours of wine; and the ready service; the abode of evening conviviality, as in the dwellings of kings for the congregated hosts. A temple of masterly construction, through gracious co-operation from the heavenly mansions: a building of regular construction, through skilful workmanship, a house of piety for the fathers.

Chief of School; heaven-arrayed benefactor; noble founder of honours; the gentle occupier has been to St. Mary the dedicator of gracious votaries. Golden ceilings are over their heads, goodly canopies in these splendid dwellings; also masses, together with writings in books: all dignified and complete.

Sacred is this dwelling by the cheerful sea. Such are the benefits conferred by Lleision: in this compact retreat will be found the warmth of hospitality and welcome banquets; and deer from the parks of yonder hill above, and salmon from the ocean, and wheat and every kind of wine —these from the bounteous land and sea.

The university of Neath; lo! it is the admiration of England; the lamp of France and Ireland; a school greatly resorted to by scholars, for every science, as if it were Sion itself; with organs for the men attired in white; and great applause of contending disputants; arithmetic, music, logic, rhetoric, civil and canon law.

As the Bernard of courts let Lleision decide; the palace of Asa be to the Abbot Lleision; as that of St. Benno, chief of the venerable sages, be the speech of Lleision; long be the life of the Abbot Lleision.

May he receive a gift to his satisfaction in this Caerbaddon of Wales: be it from the hand of Jesus to the Abbot Lleision!

Caerleon.

This town, the Isca Silurum of the ancients, during the stay of the Romans in this island was the seat of government for the division of the country called "Britannia secunda," and was the garrison for many years of the invincible Augustan Legion.

Caradoc of Llancarvan relates that during the Saxon period, Alfred the Great sent his fleet to subdue it, but was

obliged to recall his troops before they had effected the conquest, on account of the progress of the Danes.

During the occupation of the Romans this place was long the theatre for the display of Roman pomp and luxury, and for its extent considered inferior to none, as well as for the elegance of its buildings, the variety of its exhibitions, and the multifarious accommodation it afforded for gaiety and licentiousness.

Gyraldus informs us "that it was handsomely built by the Romans, adorned with sumptuous edifices covered with gilded tiles, and stately towers surrounded with brick walls, three miles in extent, had ancient temples, an amphitheatre, hot baths, subterraneous vaults for ice, hypocausts, reservoirs, aqueducts, and everything that could add to the convenience or administer to the pleasure of the inhabitants." In confirmation of this monk's account, various antiquities discovered at different periods bear ample testimony. Earthen vessels, curiously-wrought tesselated pavements, Roman bricks bearing the inscription "Leg. II. Aug.," an altar to the Emperor Antoninus; another to Jupiter, under the appellation of Dolichinus, as the patron of iron mines; another, supposed to be the Goddess Astræa, and many other votive altars, monuments, statues, inscriptions and Roman coins, from Cæsar to Valentinian inclusive, with most of the intermediate Emperors. Some of the walls are still visible in several places, but scarcely sufficient to point out the original extent of the city.

Of its splendour in the twelfth century, the description of Gyraldus Cambrensis gives a lively delineation: "Many remains of its former magnificence are still visible; splendid palaces, which once emulated, with their gilded roofs, the grandeur of Rome—for it was originally built by Roman princes, and adorned with stately edifices—a gigantic tower, numerous baths, ruins of temples, and a theatre, the walls of which are partly standing.

Here we still see both within and without the walls, subterraneous buildings, aqueducts, vaulted caverns, and, what appeared to me most remarkable, stoves so excellently

contrived as to diffuse their heat through imperceptible pores."

The following information relating to the still existing Tin Works at Caerleon is taken from 'Beauties of England and Wales,' by the Revs. J. Evans and J. Brittan, 1810:—

"The tin-works, belonging to Mr. Butler, in the vicinity of this place, are capable of manufacturing annually from 14,000 to 20,000 boxes of tin plates, containing each from 200 to 300 plates. Iron plates are rolled, also patent iron rods, ship bolts, and square iron bars. The machinery of the mill is worthy of notice: the two fly-wheels, with the water-wheels, and their combined powers, weigh seventy-five tons, and make forty-five revolutions in one minute. It is proposed to annex another system of powers to the same water-wheel, by which a weight of twenty tons will be added, and the whole revolve with the same velocity. It is said that large vessels formerly came up to the quay at Caerleon, but since the erection of a bridge at Newport, those have been unladen at that port."

Anecdote of Caerleon Bridge.

The following amusing anecdote of Caerleon Bridge is taken from a 'Walk through Wales' by Richard Pritchard Warner, published in 1798.

"The story tells so much to the credit of the ladies, that it would be unpardonable in a tourist, who is less an admirer of the sex than myself, not to detail the particulars.

"The heroine in question was a Mrs. Williams, well known in the town, and living there till within these few years; she had been to spend a cheerful evening at a neighbour's house on the eastern side of the river, and was returning home (I presume) at a decent hour and in a decorous state. The night being extremely dark, she had provided herself with a lantern and candle, by the assistance of which she found her way towards the bridge, and had already passed part of the dangerous structure. When, about half seas over, however (don't mistake my meaning), she unfortunately trod

on a plank that had by some accident lost the tenons originally fixed to the end of it, and had slipped from its proper situation; the faithless board instantly yielded to the weight of the good woman, who, I understand, was rather corpulent, and carried her through the flooring, candle and lantern into the river. Fortunately at the moment of falling she was standing in such a position as gave her a seat on the plank similar to that of a horseman on his nag. It may easily be imagined that Mrs. Williams must have been somewhat surprised by this change of situation, as well as alteration of climate. Blessed, however, with a large share of that presence of mind, or patient endurance of will, which exalts the female character so far above our own sex, the good lady was not overwhelmed (except with water) by her fall; and steadily maintained her seat on the board, taking care at the same time to preserve the candle lighted, rightly supposing it would serve as an index to any one who might be able or willing to assist her. Thus, bestriding the plank, our heroine was hurried down by the river towards Newport, the bridge of which she trusted would stop her progress, or the inhabitants be alarmed with her cries. In both hopes, however, she was disappointed: the rapidity of a spring tide sent her through the arch with the velocity of an arrow discharged from the bow, and the good people of the town had long been wrapt in slumber. Thus situated, her prospect became each moment more desperate; her candle was nearly extinguished, and every limb so benumbed with cold, that she had the greatest difficulty in keeping her saddle. Already she had reached the mouth of the Usk, and was on the point of encountering the turbulent waves of the Bristol Channel, when the master of a fishing boat, who was returning from his nightly toils, discovered the gleaming of her taper, and heard her calls for assistance, and after a considerable struggle between his humanity and superstition, ventured at length to approach this floating wonder and brought Mrs. Williams safely to the shore in his boat."

CARMARTHENSHIRE.

Donovan's 'South Wales,' 1805, speaking of Carmarthen, says :—

"At a small distance to the eastward of these deserted lead works are the tin works of Mr. Morgan.

"The iron ore employed in this manufactory is the common argillaceous kind of South Wales, intermixed with a considerable portion of the Ulverston ore of Lancashire, a rich hematite, the latter, which it is deemed necessary to smelt with the other sort in order to produce a metal of such pliability as the iron plates designed for tinning require."

Thomas Rees, F.S.A., in a description of South Wales, 1815, speaking of Carmarthen, relates, that there is an iron foundry upon a tolerably large scale at Kidwelly. There are at this place, besides, some tin mills, which at one time produced considerable quantities of this material.

A tin manufactory, now the property of Messrs. Morris and Co., has likewise been long conducted on a large scale at Carmarthen.

KIDWELLY.

The neighbourhood is rich in coals and iron ore, and some iron and tin manufactures have been long carried on here.

GLAMORGANSHIRE.

Tin-plate manufactories are numerous in this country, but the war has occasioned very considerable diminution in the demand for this article, and consequently in the quantity produced for many years past.

There are extensive tin works at Melin Griffith, on the Taff, above Llandaff, belonging to Messrs. Reynolds and Co.; the other establishments are those of Messrs. Miers and Co., which are three in number, viz., one at Aberavon, another

at Ynis-y-gerwn, a few miles above Neath, and a third at Ynis-pen-lwch, about eight miles from Swansea. Of the latter, Ynis-y-gerwn works alone are at present in a state of activity. The tin used in this manufacture is brought from Cornwall.

CARDIGANSHIRE.

At one period Sir Benjamin Hammet, and after his decease his sons, carried on some extensive tin works in the neighbourhood of Llechryd, but these are now wholly abandoned, and the buildings are pulled down and the materials sold.—'South Wales,' Thomas Rees, F.S.A., 1815.

CHAPTER XIII.

DESCRIPTION OF MODERN MANUFACTURE—TINNED PLATE OR WHITE IRON—SIZES AND SUBSTANCES—THE FORGE—FORGEMEN—PIG IRON—THE DANDY FIRE—THE REFINERY—THE HOLLOW FIRE—CHARCOAL AND COKE—THE HELVE—THE MILLS—OPENING—PICKLING—ANNEALING—TIN—PALM OIL—VITRIOL—COATING—ADVANTAGES OF TINPLATE OVER COPPER UTENSILS.

TIN-PLATE, or in other words, tinned plate, or, as the French people call it, "white iron," is a material which, in a converted shape, is familiar to everybody under the name of tin; but outside of those who are unfortunate enough to be engaged in the manufacture, or are fortunate enough to deal in or convert this useful metal, few, indeed, of the world are aware that their so-called "block tin" tea-pot, kettle, or dish-cover, is made of nine-parts iron, and one-part tin.

Tin-plates vary in size, in substance, in toughness, and in the nature of their coating: in sizes they vary from a sheet of 10 × 14 inches, suitable for a one-pound tin of provisions, to a sheet of 40 × 28, adapted for roofing purposes in the western states of America; in substance they differ from a sheet of taggers, as thin as paper itself, to a plate of ten times that thickness, adopted for the dish-covers of ordinary use; in toughness from a sheet which won't bend at all, to a sheet of charcoal-iron, which is equal in tenacity to leather itself. The coating varies with the purposes for which the tin-plates are required, the lightest coating is sufficient for mustard and biscuit purposes; the heaviest possible coating is desired for dish-covers, which have to stand planishing in conversion, and will be subsequently subject to the inevitable ceaseless "rubbing" in every careful household.

The tin-plates of commerce are packed in boxes, and, as a

rule, are bought and sold under the general terms of coke or charcoal, this distinction relating of course to the nature of the iron from which the plates were made; and these qualities are again divided into best and second quality charcoal, and best and second coke,—and even these descriptions are subdivided by clever dealers into different grades of best or worst.

It is needless to say that the value of tin-plates varies with the quality: a box containing 112 sheets, 20 × 14 inches, 112 pounds, made out of the very best charcoal-iron, handsomely coated and well assorted, will fetch a price of 25s. per box, while poorly coated unassorted second coke plates will not sell for more than 20s., although the size, substance, and weight of the sheets, are identically the same.

In describing the manufacture, it should at first be understood that subsequently to the manufacture of bar-iron in the forge, the processes of rolling, shearing, pickling, annealing, coating, and sorting, are common alike and necessary for every class of plate, but are performed more or less carefully at different works, and more or less carefully according to the class of work which is in course of manufacture.

The Forge.

It is to the forge that we must look for the good or bad nature of the iron which is the foundation of the brand. Iron well made in the forge cannot be materially affected, either for better or worse, by any subsequent process of manufacture; and on the other hand, iron poorly made cannot, by all the care in the world, be improved upon, after it has taken the shape of bar-iron.

The nature and process of puddling is so well understood, that it will be sufficient, so far as the forge goes, to confine our description chiefly to the manufacture of charcoal bar iron, the variations in the quality of such iron being more in detail than in principle,—Variation may arise from the quality and quantity of the fuel and pig-iron employed and the presence or absence of judgment and care in the

regulations for use, and in the subsequent manipulation of such materials.

To commence with the manufacture of best charcoal-iron, it may be as well to describe the forge, which consists for the most part of a long, low, open shed, or building constructed of stone, roofed with pantiles, floored with iron, the roof supported upon iron pillars or arches, so arranged as to admit plenty of air; and in connection with the forge are the engine-house, boilers, and blast-house, or blowing cylinders (as the case may be). The blast or air is made to pass round the forge in cast-iron underground pipes, and is tapped off at each fire as required for use (just as water might be); the engines are so arranged as to drive the helve hammers, rolls, and shears, which, in addition to the blast, is all the machinery that is required for the manufacture of bar-iron.

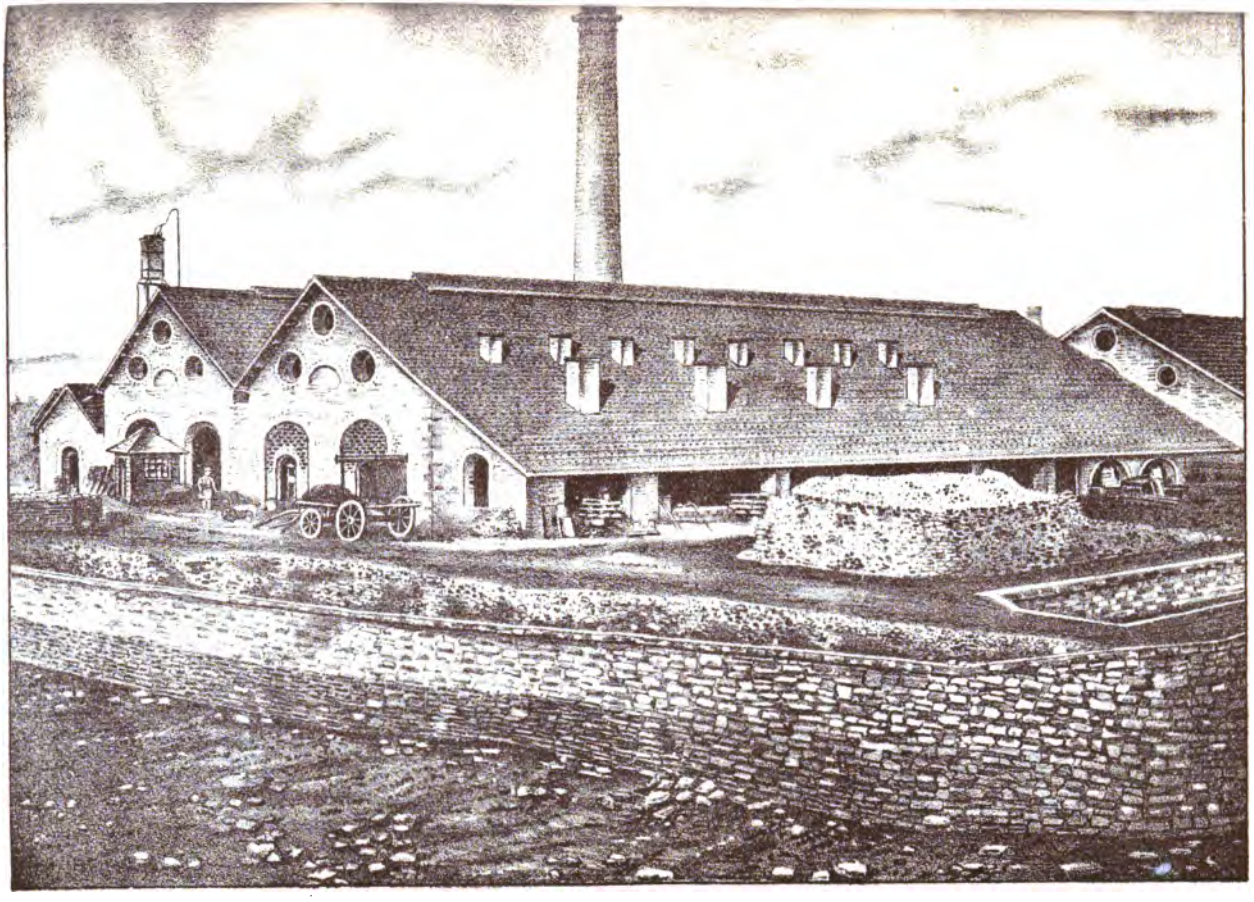
Water-power was formerly employed, and is well adapted for the manufacture of iron, but the number of such sites being limited by nature, and the demand for iron being for ever on the increase, steam was first employed for the assistance of the water-wheels, and finally forges were constructed which went entirely by steam.

Economy is claimed by old-fashioned people as the great merit of water-power, and it may be so for grist and flannel mills, where time is no object, but it seems to be doubtful, where coals are cheap, whether the larger output of iron which can be produced by steam, is not sufficient to compensate for the fuel employed; to say nothing of breakage, or of the waste which results from irregular work.

The Forgemen.

The Forgemen for the most part are strong and active, able-bodied men, apprenticed to their trade at an early age, and working on till fifty or sixty in the best of health till failing strength or disposition for lighter work causes them to retire from before the Hammer.

They are dressed and work in flannel next the skin, covered with loose fitting jackets and trousers, made of white canvas



FORGE OF MELYN TIN WORKS , 1878.

or duck, the nature of their work causes them to perspire very freely. The constant heat and perspiration renders them of delicate appetite; they eat heartily, but require something well cooked and free from fat.

The best workmen are found to be those who have been brought up in the forge from boys, passing on from job to job until their education is completed, when they in their turn know how to exact from others the duties which they have themselves performed.

The hours of work are from 6 A.M. to 6 P.M. or *vice versâ*, or until the hour within that time when the proper number of "rounds" has been completed; generally the turns are changed at the times above mentioned, when it is etiquette for the men who are leaving work to put everything about the fires ready in good order for the men who will arrive.

The men who work by day one week will work by night the next, and thus a constant change is secured. It would be unreasonable to expect anybody to follow any employment in perpetual night. They prefer the week of daywork as the time passes more quickly when they have other objects to divert their attention.

A tidy steady workman may be known by his dress and habits. When he comes down to his work punctually, bringing all he requires, and in a clean white suit on Monday morning, it may be certain that he is well looked after at home, and probably has property in some shape put away for the time when he is unable to follow his present occupation.

Many of the forgemen may be noticed with a patch of red upon one cheek as a result of constant exposure to the heat of the furnace on one side, and they frequently prefer to have clean shaven faces, as in this way they are better able to remove the effect of the dust and smoke which are inseparable from this work.

All forge work is paid for by weight, the materials are weighed *in*, and the result is weighed *out* at the beginning and end of each turn. As a rule a finer or hammerman can

earn 10*s.* for a day of ten hours, during which he only attends to his fire and to the manipulation under the hammer, all fetching and carrying being done for him by labourers, or coachers.

The Pig Iron.

At some one or two of the existing tin-plate works, the manufacture of pig iron from the ore is also carried on, but having regard to quality this is not desirable, for it is found better to manufacture tin-plate bars from a mixture rather than entirely from one brand of pig iron. One description helps the other, giving it qualities which it did not possess, and improving the "yield," i.e., the quantity produced.

The quality of pig iron best adapted for charcoal plates is known as grey forge, and is brought to Wales for the purpose of this trade very largely by sea from Lancashire and Cumberland, native iron by rail from the Forest of Dean and other local sources.

The Dandy Fire.

The dandy or running out fire is employed for the simple purpose of melting pig iron by the use of coke and blast.

The smoke stack for these fires is built upon an open framework of iron, so that the melter has access to his fire on all sides at once.

The level of these fires (which are four feet square) is made about eighteen inches above the level of the forge, so that the iron when tapped may run of its own accord into the refineries which are below it.

The duties of a melter are to carefully maintain his heat, to load and tap at the right moment, and when tapping cleverly to separate the cinder from the iron.

The Refinery.

The stack of the charcoal refinery is also constructed on an iron framework, but three sides out of four are closed

in by cast-iron plates. There is a small opening in the back through which the hot iron when tapped from the dandy passes into a nest of hot charcoal, and the finerman, who is standing in front of his fire, smothers up the iron in charcoal, turns on the blast, and from time to time works up the mass with a long bar; in about an hour he has worked it up into a ball, which is conveyed on a coach to the helve, and after being well hammered to expel the cinder, is either rolled or cut into the shape which it will retain as charcoal stamp iron, and is then thrown into cold water till it is cool enough for handling.

In the best works these stamps (so called) are hammered and trimmed with a chisel before they are passed on, but so far as manufacture is concerned, rolling is the end of the first process, and they are ready for conversion.

The Charcoal.

Charcoal was at one time the refuse of a manufacture which was carried on for the production of naphtha and sugar of lead; now the value of charcoal has been cleverly forced to such a point, it is said the chemicals are the refuse of the charcoal, which ranges in value from 30*s.* to 60*s.* per ton, and has been recently selling for a much higher price.

It might be supposed that after all these years of iron manufacture, there would have been great difficulty in obtaining fuel for the purpose, but this in fact is not the case, for there is always plenty of charcoal "offering," and it is not unusual for quantities of 1000 tons to be bought and sold in one bargain.

Formerly all the charcoal was burnt in the woods, and was carried in sacks by mules to its destination. This was all very well so long as there was plenty of wood to be found in the immediate neighbourhood; now the bulk of the charcoal is made at the charcoal works from wood which is brought from long distances by sea and rail.

The usual Welsh mode of selling charcoal is by the dozen

tubs, each measuring 36 × 36 × 20 inches, about 15 cubic feet, and weighing roughly about a ton. When charcoal is bought by measurement in the woods, the charcoal burner is privileged to measure one of his legs in the tub.

Irrespective of the subtle qualities which are given to the iron there is no fuel so safe and *reliable* in its nature as charcoal, for it is impossible to have any variation in the "quality" of wood.

The Hollow Fire.

The use of a hollow fire is peculiar to the manufacture of tin-plates, and it is employed for the purpose of creating and maintaining an intense welding heat in which the stamp iron is placed to "soak" before it is taken to the hammer, where it is welded into blooms.

The furnace is of course constructed of fire brick; it is almost square in shape, about 6 feet × 6 feet, it is flat-topped, without a smoke stack, and stands about 3 feet above the level of the forge.

These furnaces are built with doors on each side, for the use of the hammermen, who work face to face. One end is fitted with blast boxes, to blow up the heat, and at the other end is an opening into which the coke is thrown.

Thus an immense mass of heat is created at the bottom of the furnace, which is called hollow from the fact that the iron is suspended in the heat, and is not in actual contact with the fuel or the furnace.

The stamp iron is piled up in quantities of about 112 lbs., and placed upon a bar of iron forged for the purpose, small at one end, easy to handle, flat and broad enough at the other to support the stamps when placed upon it; it is about 6 feet in length, and is called a "staff."

The pile is first put into the "stove" to warm, it is then put into the fire to heat, where it is supported by means of a hook which fastens the staff to the fore plate; in about twenty minutes it is ready to go to the hammers, where the stamps are welded into one homogeneous mass, called a bloom, which is almost cut into two by a cutter, then doubled up

and returned to the hollow fire. After a further heating of ten minutes it is again taken to the hammer and again returned to the furnace, where after a final wash heat, the "bloom" is conveyed to the rolls and rolled off into bar iron.

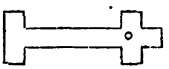
The Coke.

It is unnecessary to waste time over this manufacture which is so well understood; suffice it to say that the better the small coal, the better the coke will be, and the better the iron.

The old-fashioned open-mouthed ovens are now out of date, and it is found more economical to manufacture in closed ovens, working with flues to a smoke stack, from which a charge of 26 to 27 cwt. of small clean binding coal should produce a ton of 24-hour coke; if the coke is wanted harder it must be left in longer, but the yield is the same.

The Helve Hammer.

The helve is the oldest and at the same time the best known means of forging out iron, it is suitable equally for steam or water power.

It consists of a heavy piece of cast iron  which is lifted by a cam and falls by its own weight upon the iron which it is required to forge. There is no coaxing or nursing with this kind of hammer; it must be good iron or it will splash all to pieces, and it is sure to be well hammered for the blow regulates itself.

In former times the head of the helve was raised by the pressure of a cam coming *downwards* upon the tail, now it is always usual to raise the head by the *upward* movement of the cam, but it does not matter very much how this operation is performed so long as the hammer *does* fall, the result upon the iron is the same.

The Mills.

The bar iron is taken from the forge to the mills in the lengths to which it has been rolled, it is there cut by means of shears into such "pieces" as are suitable for the plates which are required.

A mill consists of two large open-mouthed reverberatory furnaces, two pairs of rolls or rollers—one for roughing down and singling the pieces, the other for finishing off the sheets —a doubling shears for trimming off the ends when in course of manufacture, a shearer's shears for cutting down the finished work into the sizes which are required.

The workmen consist of a roller-man, doubler furnace-man and behinder, and their names pretty well describe the nature of their occupation; the roller-man is head man and in charge of all the rest.

It is the duty of the doubler to heat the pieces of thick iron, which he hands to the roller-man, who passes them between the rolls, when they are caught or received on the other side by the behinder, who returns them over the rolls to the roller-man, who repeats the operation until the iron is sufficiently extended, when he hands back the piece to the doubler, who places it again in the furnace for re-heating: this first operation is called "breaking down."

When the returned piece has been sufficiently heated, it is taken out by the furnace-man, and again handed to the roller, who again extends it by passing it several times through the rolls, and he then hands it to the doubler, who doubles it end for end, first by means of his foot, then by the pressure of the squeezer; he then sends it back to the furnace for re-heating: this is called "singling," or "first doubling."

After re-heating, the furnace-man again hands the piece to the roller-man, who further extends it, and delivers it to the doubler, who, by means of a shears, cuts off the uneven swallow-tail ends, and returns the iron to the furnace: this process is called "second doubling."

Finally, the iron after re-heating is passed backwards and

forwards through the rolls, until by *extending* the piece to a certain length, it is known that the sheets have been *reduced* to the substance which is required: this is called "finishing," and the production is called black-plate.

The black-plate is placed by the behinder upon a framework of iron to cool, from which place it is taken (later on) by the shearer, who cuts it down to the length and width of the order for which it has been rolled.

The mills work continually by day and night, from six to six, changing turns as in the forge. Each mill can produce from 70 to 80 boxes in twenty-four hours—about four tons daily.

The mill-men earn good wages, but they are not such a steady set of men as in the forge, where they have settled down to a fixed occupation for life; in the mills they are possibly a little unsettled by constant promotion, as each boy or man is "passing on" as the opportunity offers, from behinder to furnacer, from furnacer to doubler, and from doubler to roller-man.

N.B.—It will be understood that after leaving the mill nothing can alter the size or substance of the sheets; all subsequent operations are made with a view to the "finish" of the plates.

The Opening Room.

When the rolled black-plate has been cut up by the shearer, the pieces, although to size, are eight sheets thick, and in this condition they are carried off to the opening room, which is furnished with long wooden tables, or benches, upon which, with the assistance of hand-leathers and iron opening knives, they are separated sheet from sheet by girls and women, employed for that purpose, who are very quick and clever at the work. The sheets stick together less than would be expected; sheets which cannot be separated are called "stickers," and are put aside for re-conversion in the forge; after opening they are weighed and passed on to the next process.

A girl can open 36 boxes, each 112 sheets, and earn 2*s.* to 2*s.* 6*d.* in a day of 10 hours.

The Black Pickling.

The next operation is, by the use of strong acid, to clear the surface of the plates, which have been hardened by the action of fire in the mill furnaces.

For this purpose they are plunged into a leaden bath full of vitriol heated by steam, a little saw-dust having first been placed between each sheet to facilitate the action of the acid. When the sheets are cleared, to the satisfaction of the pickler, they are washed in tanks of fresh cold water, and sent on for annealing.

If the plates happen to touch each other, the vitriol has no effect at the point of contact, and black patches remain upon the sheets, which later on produce "wasters," as the parts so affected will not take their coating.

The vitriol employed for this purpose is very strong, and the quantity necessary for the process is, as near as may be, 180 lbs. per ton of finished black-plate.

The Vitriol.

The vitriol is obtained from the chemical works which supply the charcoal; it is made from brimstone brought from Sicily, which, when heated by fire, passes off fumes, which are received in a leaden chamber above the furnaces, where they are condensed, and then drawn off into glass retorts, in which they are purified and refined for use.

When ready, the vitriol is packed and sent out in large glass bottles or carboys, covered over with wicker-work, each containing about 180.

The First Annealing.

The object of annealing is, by heat, so to soften the sheets as that they may be well adapted for taking polish or surface

when submitted to the pressure of steel rolls in the next operation.

For this purpose the sheets are piled up on square cast or wrought-iron stands, and over them, when the pile is complete, a cast or wrought-iron cover is placed, and in this condition they are placed to soak for ten hours in large reverberatory furnaces. This is a delicate operation, and requires great judgment; too much or too little heat is equally injurious. When the operation is well done they come out as soft as lead.

Cold Rolling.

This process is employed in order to obtain a smooth and even surface for the iron sheets *before* they are sent on to receive the coating of tin, and the finish of the tin-plates depends very much upon the way in which they have been cold-rolled.

If the cold-rolls are in good order, and they leave with a handsome set and finish, the appearance of the tin-plate will be all that is desired. If, on the other hand, they are buckled and streaky, all the tin-house care in the world can never improve them.

Each sheet is passed by boys through three pairs of revolving steel rolls successively, which suffices to polish the surface; but at the same time renders them *harsh* again.

Second Annealing.

To remove the harshness created by cold rolling, and in order to render the sheets soft and tough when they leave the works as tin-plates (qualities very much desired by those who convert them); the plates, after cold rolling, are again piled up in iron boxes, similar to those which have been described for the first annealing, and are again placed in the annealing furnace for ten hours, which is sufficient to remove the harshness arising from cold rolling, and renders them soft enough for future use as tin plates.

White Pickling.

The surface of the sheets having been *hardened* by the process of cold rolling and by the action of the fire in annealing, in order to prepare them for coating it is found necessary to give them a second bath of vitriol, but not nearly so strong as in the black pickling process.

The result of this second pickling is to remove the outer skin of the sheet, and to leave the pores open to absorb the molten tin.

After pickling, the sheets are washed and scoured by girls and women, and placed in tanks of fresh cold water to protect them from rust and dirt; in this condition they are ready for the tin-house.

The Tin.

The tin with which these plates are to be coated, comes to Wales either from London or Cornwall, for there are no tin smelting works in Wales.

From Cornwall it is always sent in the shape of refined blocks, each block bearing the stamp of the duchy (the well-known lamb and flag), and also the name of the smelter from whom it is purchased; these blocks, which are very much of the same size, vary very little in weight, which may be stated at 400 lbs.

To London, as the market of the world, is sent all, or very nearly all, the foreign tin which is produced, and the consumer may purchase Straits tin from Penang and Singapore, Banca or Billiton tin from Java *viâ* Rotterdam, Australian or Tasmanian, at his own discretion.

Formerly, foreign tin was very indifferently smelted, and it was necessary for consumers to refine it, involving loss of weight in addition to loss of time (and consequent expense), now it arrives well refined, free from scruff, of good colour, and for quality very much the same wherever it comes from.

Foreign tin is always bought and sold in ingots; it is of better colour and runs thinner than English tin, and on this

account it is generally employed to give the finishing coat to tin plates, English being used for the foundation or first coating, which is given by *soaking* in the tinman's pot; to give the last coat it is sufficient for the washman simply to dip the sheet in tin.

The quantity of tin used at a tin-plate works is about 5 tons weekly, for a quantity of 2000 boxes of terne and tin plates.

The Palm Oil.

The palm oil employed for this business comes from the West Coast of Africa *viâ* Bristol to Wales, in large casks containing about half a ton.

It varies in quality, as most things do; a preference is given to what is called selected Lagos oil, which goes farther, probably containing less dirt and water than the commoner sorts.

The bulk of the palm oil produced by our coloured brethren on the Gold Coast is either used for this purpose or for the manufacture of soap.

Tallow is equally well adapted for all practical purposes, but the unpleasant smell which results from melted tallow makes it impossible for workmen to employ it with any comfort.

The Tin House.

The affinity of tin for iron, and *vice versâ*, is a subject which has been frequently discussed in dissertations upon metallurgy; but we do not propose to follow up this subject, any more than to point out that the coating of three million boxes of tin-plates per annum is sufficient to demonstrate that the affinity is *very great*, and that the iron is well protected by the thousands of tons of tin which cover it.

The apparatus and appliances which are necessary for coating iron are termed a "set of pots," which are placed in brickwork with fire-places below the ground, the flues from which work into a large open-mouthed chimney or stack about 45 feet high (one for each set), which serves to carry

off the smoke from the fires, the fumes from the metal, and the stife from the grease.

The set of men for each set of pots consists of a tinman, a washman, a grease boy, and three girls employed for rubbing, dusting, and polishing the sheets.

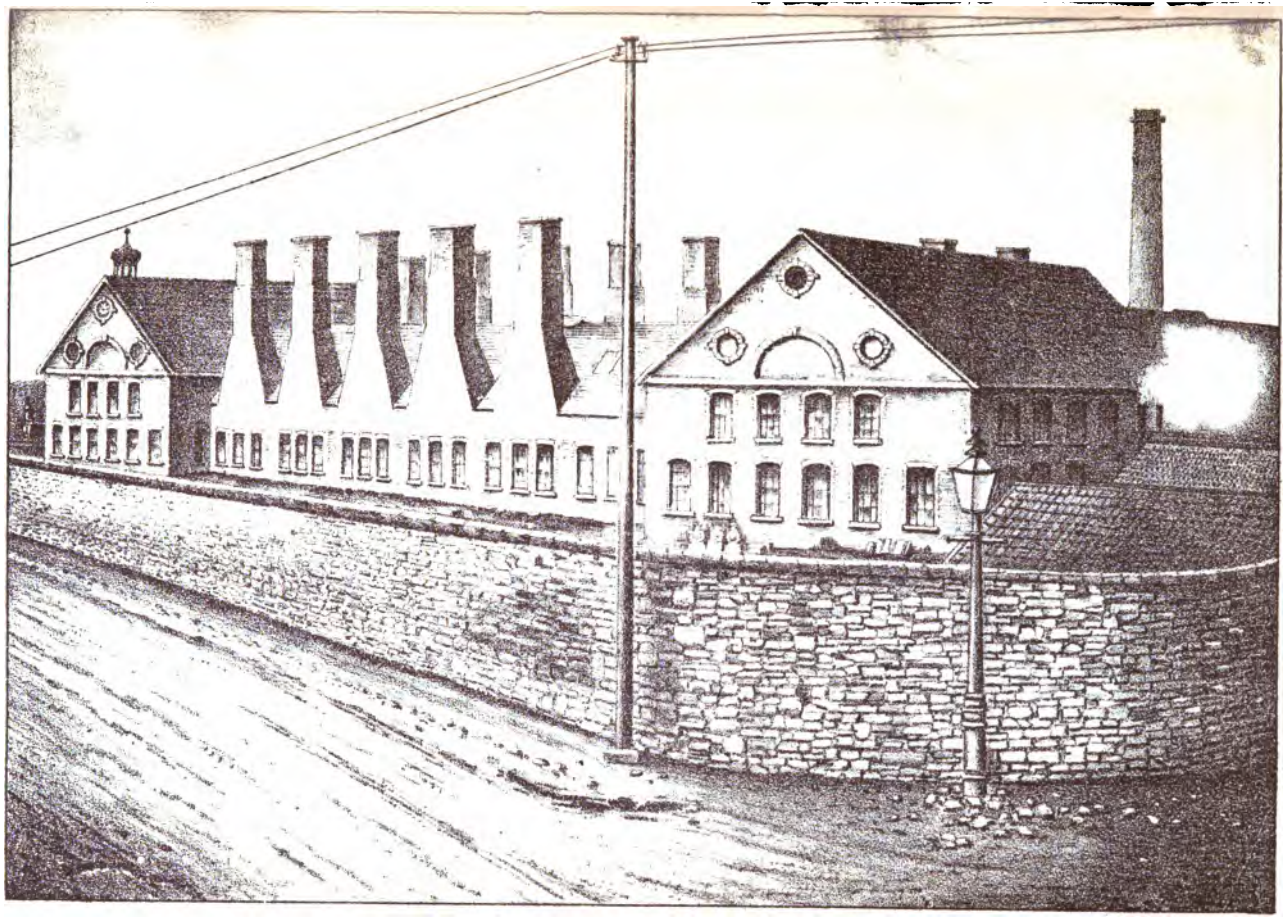
They work by the box and, producing on an average 30 boxes daily, are able to earn about 40*s.* per week.

The iron sheets or plates which were left in tanks of water in the white pickling room, are taken thence as required for use to the tin-house, and are immediately plunged sheet by sheet into a bath of heated palm oil. The sheets follow one another as they pass out of sight; thus every sheet is certain of contact with the hot oil in every part of its surface, which would not be the case if they were plunged in "*en masse.*"

The object of the palm-oil bath is to remove the moisture, to warm the iron, and to prepare the sheets for coating.

From the palm-oil bath by means of tongs, the sheets are passed by the tinman, who has charge of both pots, to the tin pot, which is full of molten tin, and here they remain to soak for a period of 20 minutes, the tinman constantly, by means of his tongs, opening and re-opening the pack (which is always *beneath* the metal), with the object of enabling the melted tin to get at every part of the surface. The result of this soaking in the tin pot is that the iron sheets absorb the tin just as a sponge absorbs the water, and the two metals, like man and wife, are joined together for better or worse, and it is very difficult thereafter to separate them; indeed, there is no means known by which the tin can in any way be extracted from the iron, and tin-plate scrap is next to valueless, although scrap iron has an important value for re-conversion in the forge.

When the sheets have been soaked to the satisfaction of the tinman, he takes them out of the tin pot and hands them to the washman, who is working close to him, shoulder to shoulder; the washman tumbles them into a pool or pot of tin, to keep them hot till he is ready for them, then, removing them in batches of about 20 sheets at a time, he places them flat upon the hob (a flat iron plate), then, with



TINNING HOUSE AT MELYN TIN WORKS, 1878.

a hempen brush in one hand and a tongs in the other, with the right hand he brushes over the sheets, first on one side, then on the other, to remove the superfluous tin which has collected *between* the wet sheets; he then with his left hand dips each sheet separately in the "wash pot," which is full of clean bright metal (generally foreign tin) to give the sheet a parting coat, and then without releasing the plate from the tongs, he drops it end on into the "patent pot," which is working side by side with him, where, by means of a lever above, and a cradle below the metal, the sheet is raised to meet a pair of steel rolls revolving on the surface of the pot, and by the pressure of these rolls the wet sheet is squeezed, and at the same time extracted from the metal. The rolls are moved by small cog wheels worked by means of a steam engine, one of which is generally attached, for the separate use of each pot.

The object of this process, which is by far the most important improvement of modern times, is to spread or equalize the metal over the surface of the sheet.

Before this invention came into general use, it was usual to finish by placing the sheets in a grease-pot or bath of palm oil to "sweat off" the tin. They were placed by the workman in a grate or basket between "pins," so called, and removed by the grease boy in rotation, as one sheet came out of the basket another went in, the number of pins employed therefore regulated the time for remaining in the pot; the fewer the pins the shorter the time, and the heavier the coating and the longer they remained the barer the sheet.

It was usual to employ a grate of five or six pins only for charcoal, while as many as up to thirty-five were employed for cheaper plates.

It will be seen that the effect of finishing by the old grease-pot process, was to make the upper edge drain over the whole surface of the sheet, and thus an uneven or wedge shape coating was produced. This involved a waste of metal, for when the upper edge was sufficiently well coated, it followed as a necessity that the lower edge carried off an

excessive coat of tin, which injured instead of improving the appearance, and which naturally increased the cost. Tin was therefore, so to speak, "thrown away," for nobody wanted it in *that* shape or would thank you for giving it.

It is needless to say that the pressure of the revolving steel rolls through which the sheets *now* pass when emerging wet with molten metal, is sufficient to give them an even coating, and it further improves the appearance of the plates.

Two processes a little different in detail, but similar in result, have been patented and licensed by Mr. John Saunders of Kidderminster, and Mr. Edward Morewood of London and Swansea. The patents date from 1860, but it was not till 1866 or thereabouts that this system was generally adopted by the trade, as a prejudice at first existed against rolled plates, but now it would be very difficult to purchase any dipped ones.

After removal from the patent pot, the plates are placed in a rack to cool, then rubbed in sharps or bran to remove the grease, next polished with sheepskins upon an iron table covered with sheepskins, and are then carried off to the sorting-room.

The Boxes.

The boxes employed for packing tin-plates are made invariably of elm timber, which is brought in large quantities across the Bristol Channel from Somersetshire to Wales for that purpose.

This timber is tough and strong and well adapted for the conveyance of heavy weights; it does not split with the nail when fastened. Of late years following the increased production of tin-plates, a trade has been established in ready-made boxes, which are more easily handled than large baulks of timber, and for a small price can be sent for long distances by rail.

A portable engine is employed to cut up the timber where it falls, and the planks are carried off for conversion into boxes at some close adjoining water-power.

Sorting, Branding, and Boxing.

When the plates leave the tin-house, they are taken to the assorting-room, where they are placed in piles upon iron faced tables fronting the light, where they are sorted over sheet by sheet by the sorters who "throw out" any defective sheets, and reject any plates of irregular substance.

Some of the sheets thus thrown out are called menders or returns, and are sent back for repair to the tin-house, others are called wasters, for which there is always a market at a reduction in price; the worst are called waster waste, and are used up for cases or sent away to Birmingham.

After sorting they are counted by girls, thus regulating the number of the sheets to the box, they are then weighed and fastened up in the boxes, which are branded by means of a hot iron to denote the contents; the size being obvious, only irregular sizes are so marked; but the substance is always described by the understood marks of 1c., 1x., 1xx., 1xxx., and so on, each x denoting an advance of 21 lbs. in weight, and some word, such as Melyn, Vernon, or Dafen is employed as a brand or trade mark, and to fix the works from which they come, and charcoal or coke to describe the quality of the iron, and a shipping mark such as A. B. C. and Co. to mark the identity of the boxes when in transit.

When purchased for export to Australia or for round the Horn to Valparaiso, or any *very* long voyage beyond the seas, it is usual to put them first in tin-lined water-tight cases, and afterwards in wooden boxes such as have been described.

Having thus described the various processes of manufacture, and before proceeding to discuss the several useful purposes for which tin plate is so admirably adapted and so usefully applied, it may not be without interest to describe how in 1747 doubts existed as to whether the use of copper and tin-coated vessels was or was not dangerous to health; fortunately the question was settled in favour of tin-plate and very much to the disadvantage of copper.

The following extract taken from the 'Gallery of Art and

Nature,' by the Rev. Edward Polehampton, and John M. Good, F.R.S., 1821, will, we hope, be sufficient to convince the most fastidious that, although there may be danger in the use of high-priced copper cooking utensils, there is nothing in the world to be dreaded from articles made of tin.

"Unhappily for mankind, the fatal accidents attending the use of copper vessels, in the preparation of food and physic, are too common and too well attested to require a particular enumeration or proof; scarcely a year passes but we hear of some of them, especially in foreign countries, and many slighter maladies originating from the same source, daily escape observation, or are referred to other causes in our own. In consequence of some representations from the College of Health, the use of copper vessels in the fleets and armies of Sweden was abolished in the year 1754, and tinned iron was ordered to be substituted in their stead. The Swedish Government deserve the greater commendation for this proceeding, as they have plenty of excellent copper in the mines of that country, but no tin. An intelligent surgeon suggested in 1757 the probability of the use of copper vessels in the navy being one of the causes of the sea-scurvy, and recommended having them changed for vessels of iron. He remarked, that of the 200 sail of ships which went to sea from Scarborough, most of them used iron pots for boiling their victuals, and that the symptoms called highly scorbutic were never seen, except in some few of the larger ships in which copper vessels were used. Notwithstanding this hint, and the example of Sweden, I do not know that any other European state has prohibited the use of copper vessels for the dressing of food on board their ships, but many of them have shown a laudable attention to prevent its malignity by inquiring into the best manner of covering its surface with some metallic substance, less noxious, or less liable to be dissolved than itself. This operation is usually called tinning, because tin is the principal ingredient in the metallic mixture, which is made use of for that purpose, and, indeed, since the year 1755, the Lieutenant General of the Police

at Paris, gave it in commission to the college of Pharmacy, to make all the experiments which might be necessary for determining whether pure tin might or might not be used for domestic purposes, without danger to health. The researches which were made in consequence of this commission by Messieurs Charland and Bayen, with great ability, were published by order of the French Government, and they have greatly contributed to lessen the apprehensions relative to the use of tin, which had been generally excited by the experiments of Marggray, published first in the 'Berlin Memoirs' for 1747. It was found that the proportion of arsenic is so wholly inconsiderable, that it is very properly concluded, that the internal use of such small portions of tin as can mix themselves with our food, from being prepared in tin vessels, can be in no sensible degree dangerous, on account of the arsenic which the tin may contain. But though tin may not be noxious on account of the arsenic which it holds, it still remains to be decided whether it may not be poisonous of itself, as lead is universally allowed to be, when taken into the stomach. The large quantities of tin which are sometimes given in medicine with much safety, and the constant use which our ancestors made of it in plates and dishes before the introduction of china or other earthenware without experiencing any mischief, render all other proof of the innocent nature of pure tin superfluous.

CHAPTER XIV.

Uses and Purposes of Tin-plates.

Having thus followed (the writer trusts intelligibly and to the satisfaction of his readers) the origin and progress of this *now* important trade from the date of its infancy in the mountains of Bohemia to the present time, when the manufacture is so firmly established in the mountains of Wales; from the time when the German works were owned by dukes and emperors, to the time when the Welsh works are in the hands of everybody; from the time when water to drive a water-wheel was all that was important, to the time when water-wheels are laughed at, and water for the boilers is all that is required; from the time when the half-finished plates were put away in cellars for three times twenty-four hours, to the time when they are "expressed" off in railway vans almost red-hot from the furnaces; from the time when the boxes were dragged over the Erzgebirge mountains by horses, and subsequently barged down the Elbe to meet the sea at Hamburgh, to the time when they are only 9 days in transit from the old world to the new; from the time when the Germans were supplying the whole of Europe with tin-plates, to the time when England sends tin-plates to the Bohemians who taught her that trade, it may now be interesting to inquire into the causes which have brought about such changes, and to examine the purposes for which tin-plates are employed. Undoubtedly the large and rapid increase of this industry is accounted for by the fact that it is left for England alone to supply the ever-increasing wants of a world which is daily advancing in population and wealth.

This monopoly arises, and we may almost say is secured, to England by the natural advantages which we enjoy in the

possession of abundance of suitable materials, assisted by labour well skilled and well adapted by their careful and industrious habits to carry out the intricate details of the manufacture.

These advantages and facilities, particularly in Wales, are of such a decided nature, that the trade is almost placed beyond the limits of foreign competition; and, as it used to be said of Germany, so it may now be said of Wales that it is the Welshman's own trade.

There is, to be sure, a certain limited and stationary production in France and Germany, but it is hardly sufficient to meet their own requirements; and if it were not for special sizes, and old-fashioned prejudices, assisted by a protecting tariff, it is certain that the French makers would be undersold and driven out of their own markets by English competition.

But the manufacturer would find it useless, and even ruinous, to extend his manufacture if there were no markets ready to receive the goods which he produced; the dealer, in his turn, in the absence of sufficient and moderate priced supplies, would be unable to extend and carry on his business to advantage; and, again, both have to look to the actual consumers for support.

It is one of the strangest features of trade that few or none of us care much to know where the goods come from or where they will go to, it seems to be sufficient that they can be obtained when required and sold when obtained.

We are all of us unconsciously carrying out the unwritten but inevitable laws of demand and supply.

The Dutch or Irish emigrant far away in his tent on the boundless prairies of the West, the boatman barging down his cotton over the bosom of the Mississippi, the Father of Waters, the rough miners of Nevada fighting with nature to extract the virgin silver from the heart of the Rocky Mountains, all require tin-ware in its rudest form, a tea-pot, a kettle, a pannikin, a wash-bowl, and requiring them are well aware that they will find them ready when desired at the nearest country store.

The emigrant has been first mentioned because there is no

doubt that the immense modern increase in the manufacture and consumption of tin-plates has resulted from the rapid increase of population in the United States of America.

But the tin-plates which are exported so largely to the States are not by any means altogether for the use of the emigrants, with the advance of wealth all over the world comes also the demand for provisions of luxury, and this country, so abundantly favoured by nature in the productions of soil and climate, has created a trade in preserved provisions of such importance that there is scarcely a city or large town either in Europe or the Colonies where you cannot find oysters and peaches in canisters labelled from Baltimore.

The rocky coast of Maine, by means of tin canisters, supplies the whole world with lobsters, which are packed or canned at Portland, and California exports largely of the fruit and vegetables which are grown to such perfection in the splendid climate of the Golden State, in addition to salmon, which is sent to Europe both from the Atlantic and Pacific coasts, from Portland in Oregon, and also from Portland in Maine.

The use of tin-plates for packing purposes in Baltimore is enormous; it has been estimated at 150,000 boxes, equal to 45,000,000 of 1 lb. cans per annum: the produce packed is miscellaneous, but oysters and peaches are the principal items of export, for which the capital of Maryland is so famous.

These oysters, which are said to be the finest in the world, are dredged, for the most part, in Chesapeake Bay, and brought to Baltimore in ship-loads for sale, and, when sold, they are carried off in cart-loads to the factories.

Here they are tipped out on the ground-floor, and shovelled into a large iron frame-work or basket, which, when full of oysters, is hoisted by a crane to the floor above, where the basket is dipped into a tank of boiling-water, by which means the oysters are killed and the shells are opened, after which they are taken out of the shells by women and girls, who select them for size and place them in canisters: the shells are burnt for lime.

The soil and climate of Maryland are well adapted for peaches, which are largely grown in orchards, and the greater

portion of those packed in Baltimore come from the immediate neighbourhood; but when the crop is deficient in one place, it is not unusual to carry off the canisters by rail, and to pack the fruit in some other part of the country where the crop is more abundant. The merits of green-corn, or maize, are best known and best appreciated by consumers in the United States, it is but little known and seldom used elsewhere.

The track of the Pacific Railway, from the mighty Missouri to the Sierra Nevada, bear evidence to the popularity and usefulness of these canned provisions, for at every depôt certainly, and at frequent intervals along the line, may be seen in abundance empty canisters which have served their purpose and been left behind.

A further very large use for tin-plates in America is known to be for petroleum, which, packed in tin, is comparatively harmless in transit; and this valuable ready-made gift of nature first pumped from the earth, and then well-refined, (when canned) is handsomely labelled and under the name of astral oil, or similar titles, is sent away in ship-loads to every quarter of the globe.

One petroleum firm in the City of New York is said, when in full season, to cut up 600 boxes (30 tons) daily for this purpose.

Before leaving the United States, we must not fail to call attention to the stamping factories and "stamped ware" of that enterprising country. Formerly the conversion of tin-plates for domestic purposes might be almost called the gipsies' trade—pots and kettles, made of the worst material, put together by idle worthless men, were hawked about by brown-faced women from village to village, and from door to door; and to call an honest man a "tinker" was to use a term of reproach. Now, in all the large cities of the United States, may be seen handsomely constructed factories of three and four stories, fitted with steam and hydraulic power, where by means of stamps which fall, or of presses which work by upward pressure, they convert circles varying from 14 to 26 inches, into pans and wash-bowls of every conceivable size and shape, made without seam from top to bottom,

and which are as far superior to the old-fashioned, soldered up article as an express train is to the old stage-coach.

The use of this stamped ware is certain to increase, for the articles thus made are cleaner and stronger than any other material. You can only wear them out by rubbing right through them, and they travel very cheaply, for the pans being made with a taper, they pack very closely: this business of stamping has created an altogether new use for the best qualities of tin-plate.

We say the best, because none but the very best plates are able to stand the severe test of the stamps, they must be soft and tough, and free from blemish of every sort, for
c should a sheet "give out" in the process of manufacture, all the first cost and all the labour bestowed upon it, up to that point, are money thrown away, for no one will buy an imperfect milk-pan, and for this reason none but the very best brands are employed for this purpose.

Further, in the town of Nantes and the immediate neighbourhood are to be found numerous establishments where they pack largely of green peas, haricot beans, asparagus, and other vegetables, fish, game, and fruit, to say nothing of almost every made French dish to be found in the *menu* of modern hotels; for all these things there is a large foreign demand, and Nantes grows rich by feeding the world with vegetables when out of season, and by the supply of provisions which they understand better in France.

The consumption of tin-plates for provision purposes in the town of Nantes is estimated at 50,000 boxes, 2750 tons per annum.

The European consumption, about 500,000 boxes per annum, is not very grand, in fact it amounts to nothing at all when compared with the 1,600,000 boxes which are sent to the States.

There is certainly a steady yearly increase in the totals to Italy, Germany, Spain, and the Baltic, in fact to all the ports, but the growth of these old countries is very slow, indeed, as compared with the U. S. A. export, which has expanded from 800,000 to 2,000,000 boxes since 1865.

In China and India the use of tin-plates for domestic purposes seems to be almost unknown, a yearly quantity of 40,000 boxes being all that is sent for the supply of those enormous populations; it is supposed, however, that sooner or later those markets will be opened very widely, but at present there is an utter want of knowledge of conversion, and further prejudices exist in favour of yellow metal articles of their own peculiar shapes.

Possibly the largest European use for tin-plates is to be found at Nantes, in Brittany, the seat of the sardine trade, where they also export very largely of preserved fruits and vegetables.

The square neatly made boxes of sardines, with which all countries are familiar, is made from tin-plate of a superior quality; the boxes for the most part are manufactured in the town of Nantes, and sent down empty to the fishing establishments on the coast, where they are warehoused waiting the arrival of the fish. The fishing season for sardines is from June to September, and all along the coast of Brittany, from Finisterre to La Rochelle, are to be found establishments filled with every necessary appliance for catching, preparing, and packing up the fish.

There is, further, a large consumption of tin-plates for roofing purposes in America, a use which is almost peculiar to that country; the material recommends itself by its portable character, as the weight for the same area is not one-tenth that of slates, there is further an economy in the smaller quantity of timber which is required to support such a much lighter weight. A tin roof well painted and well put together will serve its purpose for many years.

Tin-plates and terne-plates are both employed for roofing, but the latter for choice, as the coating is generally heavier and better calculated to resist the weather.

Terne-plates are manufactured in sheets of 20×14, 20×28, and up to 40×28 inches, the coating, a mixture of tin and lead, is in point of fact pewter, and is well suited for the purpose.

The use of the French word terne or dull, which describes

these plates, seems to show that they were made in France before they were made in England, probably at one of the works which we have spoken of as started by M. Jean-Baptiste Colbert.

Terne-plates are also largely used all over the world for the lining of packing cases, to protect valuable goods from damage when at sea, and as the only object is to produce such a package as will keep out the salt water, the poorest material, i.e., indifferent iron poorly coated, or even waster plates are quite good enough for this purpose, at the same time the quantity thus used is most important.

Turning to the Antipodes, we find here also a certain use for tin-plate in the pannikins and tea-pots employed in the bush by emigrants, stockmen, diggers, and shepherds; and also a further large consumption in the tins employed for "Australian meat."

The quantities sent to Europe in 1872 and 1873 were enormous, but latterly the sale has fallen off, in consequence of a prejudice against the use by the lower classes; and the export has also been checked by increase of cost arising from the higher value of sheep and cattle in the Colonies.

If meat continues at its present high price in England, and stock returns to its former value in Australia, then we may take it for certain that price will conquer prejudices, and this trade will be revived.

Beef and mutton in this shape, although unpopular in the workhouse, is very much appreciated by English sailors, and is largely included in the ships' stores, both of the navy and merchant service; and it was the great support of the British army when carrying on their successful operations against King Koffee of Ashantee.

Perhaps, in England, for provision purposes, the largest use may be for biscuits, and for mustard, which, like the British army, seem to have conquered every country.

Reading biscuits are almost as well known all over the world as at Reading, and Colman's mustard is better known in the Colonies than in Cannon Street.

The quantity of these goods exported is enormous, and is

constantly increasing, and, as a consequence, the demand for tin-plates must also constantly increase, for it is impossible to find a lighter or a stronger package which will convey its contents to India or Peru as fresh and as crisp as when they left the English warehouse.

In the case of mustard, it is not what they use, but what they waste, which produces such great demand, for it is probable that half of all the mustard made is thrown away; and in the same way of tin-plates, of the enormous quantity cut up for canisters a very large proportion is unavailable for future service.

We have instanced Messrs. Huntly and Palmer, and Messrs. Colman, as being very large consumers; but there are also many other large firms all over England engaged in these trades.

For the packing of gunpowder there is nothing like a tin canister, as no material is better calculated to resist the damp, and at the same time it serves as a very great protection to life and property when this dangerous article is in transit, not only when moving about to meet the wants of home consumption, but when exported as it is in very large quantities for the use of our friends and enemies beyond the seas. England prospers by free-trade, and she does not refuse a free use of her gunpowder to either friend or enemy (who is ready to pay for it).

The consumption of the United Kingdom is variously estimated at from 500,000 to 750,000 boxes per annum; but, without exact returns of the total made, it is impossible accurately to fix this quantity.

Returns have been made to Government by most of the works, but several manufacturers have refused to furnish the necessary information. It is difficult to understand how individual interests can be effected by giving information which is received in confidence, or by furnishing the detail of particulars which are only published as a whole; however, as it is, so it is, and we must wait for the coming of more enlightened ideas.

We have not referred to the large uses for tea and coffee,

matches, tobacco, jams, and bonbons, soup, fish, arrowroot, revalenta baking powder, blacking, and the many other articles in daily use, which handsomely covered with paper labels, or still more handsomely finished by the new decorating process, are to be seen in shop windows wherever you pass, for it would be useless, and it would be wearisome to follow any further in detail the almost endless purposes to which we have, perhaps, already too fully referred, to those who are interested in the trade the present position is well known, but the future is before us, and it may not be without interest to examine whether our prospects are backwards or forwards in the future of the trade.

To examine this question closely it is only necessary to consider whether there is any prospect that any one will be wanting less in the future than in the past of any of those articles for which tin-plates are employed.

It seems to be inevitable that we shall all be wanting more of them, and it is equally certain that a crowd is pressing on behind who, in the future, will consume tin-plates who have not used them in the past, both in our country and those distant markets which are being opened-up daily by the railroad and the steamer.

We may particularly instance the United States of America, to which country, until very recently, a new population was pouring in at the rate of 1000 emigrants daily, and where in every town and village from East to West, from the Atlantic to the Pacific, from Puritan New England to Sunny California, from the Gulf of Mexico to the Falls of Niagara, may be found tin-smiths' stores which are bursting with all that is necessary for the use of these emigrants.

Does any one doubt the future of that great country? Will any one reason that they are to go backwards in the world? And, finally, who can place a limit upon the future requirements of our Colonies—of that Greater Britain beneath our feet—where Britons, in every meaning of the word, pride themselves on being sons and heirs of the British Empire, members of that Imperial race which has overspread the world from one end of it to the other, and which carries with

it everywhere the blessings (and the industry) of its own well-ordered freedom, its glorious memories of the past, and its still more glorious hopes for the future.

It has been estimated that at the close of the present century the Crown will have nearly as many subjects of European descent in the Colonies as in the United Kingdom.

Will *their* wants cease or slacken?

Rather (as Governor Gilpin has said of the future of Colorado), rather let him who doubts seat himself upon the banks of the supreme Missouri River and await the running dry of his yellow waters, for sooner shall he see this than a cessation of the trade which now exists between Britain and the English speaking sons of Britain in every quarter of the globe.

APPENDIX.

A.D. 1691.—SPECIFICATION No. 282.

MANUFACTURE OF TINNED PLATES (HEMMING'S PATENT).

WILLIAM and MARY by the Grace of God King and Queen of England Scotland France and Ireland Defenders of the Faith &c. To all to whom these Presents shall come Greeting.

Whereas Edmund Hemmings hath by his humble petition represented unto us that he has at his great care and expense, found out an Art or Invention for "making of iron plates tynned over, comonly called tynned plates, as good as those brought from and made in Germany" which invention hath not yet been heretofore knowne or practised by any of our subjects and hath prayed us to grant him our Letters Patent for the sole use thereof during the terme of 14 years &c.

Know ye therefore that we being willing to cherrish and encourage all laudable endeavours and designs of such our subjects as have by their industry found out useful and proffittable arts misteries and inventions and that the said Edmund Heming may accordingly reape some fruit and benefitt of his labour and charge in and concerning the premises of our espesiall grace, certaine knowledge and mere moc'on have given and granted and by these presents do give and grant unto the said Edmund Heming his executors administrators and assigns especial lycence power privilege and authority that he and they by him and themselves and by his and their deputies servants agents and workmen and such others onely as he the said Edmund Heming his executors administrators and assigns shall agree with shall and may from time to time and at all times hereafter dureing the space of fourteen yeares next ensuing the date of these presents at his and their owne propor costs and charges erect use teach

exercise and put in practice the said new invention soe by him contrived and found out as aforesaid in any place or places within our Kingdome of England Dominion of Wales and Town of Berwick upon Tweed and also shall and may receive take and enjoy all the benefitts comand and further to be answerable to the said Edmund Heming his executors administrators and assigns according to the utmost rigour of the law for his and their damages thereby susteyned. And further we doe by these presents for vs our heires and successors give and grant onto the said Edmund Heming his executors administrators and assigns full power and authority that he they and every of them his their and every of their deputies agents and servants having first obteyned a Warrant in that behalfe from the Lord Chiefe Justice of our Court of Kings Bench for the time being with the assistance of a constable or other lawfull officer (as well within liberties as without) at convenient times in the day dureing the terme aforesaid and in a lawfull manner shall and may make search in any place or places within our said Kingdome of England Dominion of Wales and towne of Berwick upon Tweed where there shall be iust cause of suspition for discovering and finding out of all such person or persons as shall imitate make or vse or cause to be imitated made or used within our Kingdome or dominion aforesaid the said new Invention soe by the said Edmund Heming found out and invented as aforesaid that soe such offender may be proceeded against and punished according to the utmost rigour of the Law. And further we doe by these our Letters Patents for vs our heires and successors will authorize require and comand all and singular justices of the peace mayors sheriff bayliff constables head boroughs and all other officers and ministers whatsoever of us our heires and successors now and for the time being whom it may concerne that they and every one of them respectively be from time to time dureing the terme hereby granted in their respective offices and according to their and every of their best skills and endeavours ayding helping and assisting unto the said profitts comodities and advantages of and by the said new Invention to be had made acquired and gotten to his and their own proper benefitt use and uses. To have hold use exercise and enjoy the said lycence powers priviledges and authorities and all other the premises by these presents granted or menc'oned to be granted unto the said Edmund Heming his executors administrators and assigns for and dureing and unto the full end and terme of fourteen yeares from the date of these presents next

ensuing and fully to be compleate and ended according to the statute in that case made and provided. And to the end the said Edmund Heming his executors administrators and assigns may the better enjoy the full and whole benefitt and the sole use and exercise of his said new Invention we doe by these presents for us our heires and successors streightly charge require and comand all and every person and persons bodies politique and corporate of what quality degree name or condition soever they be within our said Kingdome of England Dominion of Wales and towne of Berwick upon Tweed that neither they nor any of them dureing the said terme of fourteen yeares hereby granted either directly or indirectly doe use exercise or put in practice the said new Invenc'on so by the said Edmund Heming invented and found out as aforesaid nor doe nor shall counterfeite imitate or resemble the said Invenc'on or any materialls or ingredients thereunto belonging nor doe nor shall make any addition thereunto or substracc'on therefrom whereby to pretend themselves the inventors or devisors thereof without the lycense consent or agreement of the said Edmund Heming his executors administrators or assigns in writing under his or their hands and seales first had and obteyned in that behalfe under such paines and penalties as can or may be inflicted on the offender or offenders therein for the contempt of this our royall Edmund Heming his executors administrators and assigns deputies agents and servants in and by all things in and about the accomplishment of our royall will and pleasure hereinbefore declared and in the execution of the severall powers and priviledges hereby granted as aforesaid. And moreover we doe by these presents for us our heires and successors will and comand that our said respective officers and ministers before menc'oned or any of them doe not nor shall at any tyme hereafter dureing the terme hereby granted in anywise molest trouble or hinder the said Edmund Heming his executors administrators or assigns deputies agents or servants in or about the use or exercise of the aforesaid Invenc'on or any part thereof or anything relating thereto provided alwais and these our letters patents are and shall be upon this condic'on that if at any time dureing the said terme of fourteen yeares hereby granted it shall be made appear to us our heires or successors or any six or more of our or their privy counsell that this our grant is contrary to law or preiudiciall or inconvenient to our subjects in generall or that the Invenc'on before menc'oned is not a new Invenc'on as to the publicke use and

exercise of the same and not invented and found out by the said Edmund Heming as aforesaid then upon significa'on and decla'con of such prejudice or inconveniency to be made by us our heires or successors onder our or their signett or privy seale or by the lords or others of our or their Privy Counsell or any six or more of them under their hands these our Letters Patents shall forthwith cease determine and be utterly void to all intents and purposes anything hereinbefore conteyned to the contrary notwithstanding provided alsoe that these our letters patents or anything herein contained shall not extend or be construed to extend to give priviledges unto the said Edmund Heming his executors administrators or assigns to imitate any invenc'on or works whatsoever which hath been found out by any other of our subjects whatsoever and publickly exercised within our Kingdome or Dominion aforesaid to whom we have already granted our like Letters Patent of priviledge for the sole exercise and benefitt thereof it being our will and pleasure that the said Edmund Heming his executors administrators and assignes and all and singular other person and persons to whome we have already granted our like Letters Patents and of these presents. And lastly we doe hereby for us our heires and successors grant unto the said Edmund Heming his executors administrators and assignes that these our Letters Patent or the Enrollment hereof shall be and continue in and by all things good vallid firme and effectuall in the law according to the true meaning of the same notwithstanding the not full and certaine describing or mentioning of the said Invenc'on or of the materialls or imperf'con in these presents or any other matter cause or thing whatsoever to the contrary in anywise notwithstanding.

In witness etc.

Witness ourselves at West^{m} the seventeenth day of October.

By Writ of Privy Seale.

TIN STATISTICS.

THE following official information relating to the production of the Tin mines in Cornwall and Devon has been taken from the Government Returns as published in Hunt's *Mineral Statistics of the United Kingdom* for 1874.

TIN.

PRODUCE of the MINES and STREAM-WORKS, &c., of Cornwall and Devonshire according to the Returns obtained from the Smelters in 1874:—

Tin Ore.	Value.	Metallic Tin.	Value.
Tons. cwts. qrs. lbs.	£ s. d.	Tons.	£ s. d.
14,039 7 1 7	788,310 0 0	9,942	1,077,712 0 0

PRODUCE of the MINES and STREAM-WORKS, &c., of Cornwall and Devonshire as returned by the Mines to the Mining Record Office, to the Inspector of Mines, to the Stannary Court, and to the Duchy of Cornwall:—

	No. of Mines, &c.	Quantity of Black Tin.	Value of Black Tin.	Metal produced.	Value of White Tin.
		Tons. cwts. qrs. lbs.	£ s. d.	Tons.	£
CORNWALL:—					
Western District	26	2,599 4 0 14	139,083 3 6		
West Central District	85	8,852 2 0 3	483,587 19 6		
East Central District	28	985 8 3 17	56,001 3 10		
Eastern District	14	637 18 3 14	32,495 16 3		
DEVONSHIRE	10	1,082 20 1 4	10,356 1 6	9,724	1,084,081
Tin sold in the Stone in *both Counties*	23	411 10 0 0*	23,041 15 0		
Tin Streams in *both Counties*	19	146 6 1 3	6,794 2 0		
Rivers in ditto	25	. . . . .	1,881 0 0		
	230	14,715 7 1 27	753,241 1 7	9,724	1,084,081

* From 21,783 tons 3 cwts. 0 qrs. 21 lbs. of Tin Stone.

SUMMARY of PRODUCE (Cornwall and Devon) for each of the Ten Years ending 1874, with the respective Values of Ore and Tin and the Number of the Productive Mines:—

Year.	No. of Mines.	Tin Ore.		Metallic Tin.	
		Quantity.	Value.	Quantity.	Value.
		Tons.	£	Tons.	£
1865	156	14,122	782,284	9,038	873,659
1866	145	13,785	667,999	8,822	781,849
1867	117	11,066	549,375	7,296	670,228
1868	109	11,584	641,137	7,703	756,494
1869	117	13,883	889,378	9,356	1,138,488
1870	147	15,234	1,002,357	10,200	1,299,505
1871	145	16,898	1,068,733	11,320	1,556,557
1872	162	14,266	1,246,135	9,560	1,459,990
1873	215	14,885	1,056,835	9,972	1,329,766
1874	230	14,039	788,310	9,942	1,077,712

PRICES of COMMON BLOCK TIN during the present Century.

Year.	Price per Ton.	Year.	Price per Ton.
	£		£
1800	92	1852	90 to 98
1806	112	1853	123 to 127
1810	145	1854	117 to 130
1811	128	1856	129 to 142
1813	130	1857	108 to 146
1814	150		
1815	130		£ s. d.
1816	110	1858 average	119 2 2
1817	92	1859 „	131 18 3
1818	84	1860 „	136 3 1
1819	74	1861 „	122 5 0
1820	72	1862 „	116 0 0
1822	90	1863 „	117 0 0
1823	116 to 184	1864 „	107 1 0
1826	78	1865 „	96 5 0
1828	72	1866 „	88 12 6
1830	74	1867 „	91 17 3
1836	99 to 126	1868 „	98 0 0
1837	88 to 95	1869 „	123 2 0
1840	81	1870 „	127 8 6
1842	67 to 73	1871 „	137 10 0
1843	60 to 64	1872 „	152 15 0
1845	78 to 106	1873 „	133 7 0
1850	81 to 84	1874 „	108 8 0
1851	89		

RETURNS made from the TIN MINES of Cornwall and Devonshire to the Mining Record Office, to H.M. Inspector of Mines, and to the Stannary Court in 1874:—

CORNWALL—*Western District.*

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Argus Huel	6	9	0	10	363	4	0
2	Balleswidden	3	0	0	0	126	0	0
3	Balleswidden East	3	13	2	3	157	10	0
4	Boscaswell East	10	18	3	12	532	14	10
5	Boscaswell Downs	65	0	0	0	3,404	0	0
6	Botallack and Carnyorth	401	10	0	15	22,717	8	9
7	Carn-Galver	38	8	3	3	1,795	8	2
8	Cunning Huel United	77	16	2	22	4,150	14	7
9	Ding Dong	268	3	0	8	15,206	12	6
10	Hermon Huel	7	0	2	14	350	0	0
11	Levant	150	2	3	20	8,024	4	6
12	Levant North	126	16	3	1	703	6	0
13	Margaret Huel	106	9	2	23	5,409	6	7
14	Margaret Ann	1	1	0	12	48	0	0
15	Mary Huel	176	17	1	0	9,940	15	2
16	Morvah Consols	5	17	1	13	328	10	0
17	Owles Huel	208	0	0	0	13,520	0	0
18	Polpeor (*late* Huel Kitty)	109	1	0	25	6,065	15	0
19	Providence	187	16	1	16	11,002	8	3
20	Rosewall Hill and Ransome United	131	0	3	11	7,487	15	4
21	St. Ives Consols	138	6	1	10	7,499	9	0
22	St. Just Amalgamated	151	12	3	8	9,009	2	6
23	Spearn Moor	94	9	1	17	4,797	1	0
24	Trelyon Consols	13	12	0	22	729	3	0
25	Trencrom	107	14	0	9	5,321	14	4
26	Trevagean, Great	8	15	3	20	393	0	0
	Total of Western District	2,599	4	0	14	139,083	3	6

West Central District.

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Balmynheer	10	18	1	16	570	7	11
2	Basset Huel	310	18	3	26	17,199	10	1
3	Basset East Huel	12	7	3	26	744	2	9
4	Basset and Grylls	135	11	0	16	6,775	13	2
5	Basset West	300	12	1	0	13,527	0	0
6	Blencowe	4	19	0	13	311	12	4
7	Blue Hills	66	4	0	0	3,671	1	7
8	Bosworgey	10	4	0	3	582	0	10
9	Budnic Consols	2	6	0	19	130	0	0

West Central District—(Continued).

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
10	Buller Huel	2	19	1	23	43,511	8	8
11	Busy Great Huel	1	11	3	9	75	5	4
12	Calvadnack	17	5	1	16	792	0	0
13	Carn Brea	652	9	0	16	37,780	2	10
14	Carn Brea South	119	7	3	12	6,486	9	11
15	Clifford Amalgamated	19	0	0	10	907	19	8
16	Coates Huel	20	5	3	20	1,126	18	4
17	Coit Huel	13	2	0	18	585	10	0
18	Coit Huel Stamps	26	15	0	23	1,320	13	2
19	Comford Huel	19	12	3	0	975	0	0
20	Condurrow South	475	6	3	10	26,896	6	8
21	Cook's Kitchen	239	18	3	15	14,069	13	0
22	Creegbraws United	31	15	2	22	1,612	0	0
23	Crenver and Abraham	38	14	1	10	1,637	0	0
24	Crofty North Huel	50	19	0	19	2,861	0	0
25	Crofty South Huel	180	6	3	7	8,624	16	8
26	Dolcoath	1,120	19	1	26	65,558	16	5
27	Florence Consols	43	7	2	14	2,541	13	2
28	Fortune Great Huel	18	1	1	6	952	0	0
29	Frances South Huel	97	5	3	9	5,848	7	6
30	Frances West Huel	275	18	3	1	13,676	16	9
31	Friendly Huel	4	8	0	6	207	10	0
32	Godolphin West	110	18	3	0	6,275	12	0
33	Gorland West Huel	22	19	1	8	1,288	10	0
34	Great Work Consols	56	0	2	13	3,389	7	0
35	Great Work South	38	10	3	0	1,493	0	0
36	Great Work West	14	4	2	0	739	0	0
37	Grenville Huel	123	8	2	8	6,941	18	2
38	Grenville East Huel	25	3	3	11	1,380	16	4
39	Jane Huel	249	14	3	26	14,255	18	3
40	Jane North	0	16	1	19	25	0	0
41	Killefreth	20	4	1	23	1,163	10	7
42	Kitty Huel (*St. Agnes*)	197	19	1	7	11,515	6	4
43	Lovell East Huel	140	0	0	18	8,193	12	3
44	Lovell Great Huel	9	4	3	8	522	12	1
45	Lovell New Huel	10	15	3	13	624	14	1
46	Lovell North	2	0	0	11	113	15	2
47	Lovell, The	57	1	0	10	3,232	14	9
48	Medlyn Moor	1	12	1	14	92	19	4
49	Metal North and Harriet	0	10	0	0	21	0	0
50	New Consols	51	14	2	4	2,632	8	6
51	Osborne Huel	1	14	0	1	110	9	9
52	Parbola	60	16	2	9	2,745	0	0
53	Pednandrea United	349	15	0	20	21,220	0	0
54	Penhalls	229	0	0	0	13,193	18	10
55	Perran Consols	18	19	3	5	855	9	6
56	Peevor Huel	50	1	2	20	2,527	0	6
57	Penberthy Consols	27	4	2	10	1,211	10	0
58	Penstruthal	36	17	2	26	2,069	10	0
59	Prudence Huel	0	7	3	0	14	4	2
60	Polberro	52	8	1	1	2,900	8	4
61	Polbreen	5	14	3	14	343	0	0
62	Poldice, The	20	12	0	21	1,111	17	11
63	Poldice West	38	14	0	16	2,273	19	3

West Central District—(Continued).

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
64	Polrose	61	3	1	17	3,257	11	8
65	Pool East	419	18	9	9	19,392	14	11
66	Polpeor	106	8	1	22	5,886	19	6
67	Rosewarne New	41	14	0	25	2,496	4	10
68	Rosewarne New West	9	18	1	18	611	18	0
69	Rosewarne United	32	9	3	0	1,452	10	0
70	Roskear North	30	18	3	14	1,875	7	1
71	Roskear South	18	2	3	0	975	0	0
72	St. Agnes Consols	10	11	9	2	337	14	0
73	Scorrier Consols	6	17	2	10	338	14	7
74	Seaton Huel	68	10	3	8	3,868	14	2
75	Seaton West Huel	177	9	2	0	9,874	18	10
76	St. Aubyn United	25	0	1	0	1,277	3	9
77	Tincroft	685	17	1	17	38,349	19	9
78	Tremenhere	21	9	3	13	1,073	16	10
79	Treleigh Wood	116	4	1	18	5,910	11	6
80	Treskerby North	5	9	0	4	239	12	2
81	Trevaunance	18	18	1	17	855	0	0
82	Trumpet Consols	154	5	3	5	8,208	1	5
83	Uny Huel	320	2	3	4	17,827	2	0
84	Unity Wood Huel	90	0	3	9	2,414	17	10
85	Vor Great Huel	83	10	1	24	4,428	19	8
	Total	8,852	2	0	3	483,587	19	6

East Central District.

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Belowda Hill	4	11	1	13	283	0	7
2	Boscoppa	1	18	1	10	101	6	7
3	Bunnie Huel	4	0	0	0	180	0	0
4	Burney House	8	0	3	10	362	11	0
5	Carclaze	4	17	3	26	281	15	9
6	Charlestown United	120	13	2	24	6,887	3	11
7	Cornubia	6	3	0	9	273	5	0
8	Eliza Huel Consols	221	7	3	25	12,629	0	2
9	Eliza West Huel	8	8	2	10	477	6	4
10	Fortescue	3	17	1	22	178	15	0
11	Gover Mine	6	8	2	16	375	5	11
12	Kerrow Moor	3	9	2	5	199	16	7
13	Leeds and St. Aubyn	6	1	3	13	415	19	8
14	Mary Huel (*St. Dennis*)	3	19	3	6	161	15	9
15	Minear Downs	38	5	0	15	1,995	14	10
16	Mulberry Hill	60	5	0	10	3,276	15	9
17	Mulberry East	4	0	0	0	180	0	0
18	New St. Blazey	2	1	1	21	95	10	0
19	Park of Mines	231	18	2	11	13,744	15	5
20	Pembroke New	144	12	3	13	8,366	1	0
21	Polgooth Great	22	3	3	7	995	10	0

East Central District—(Continued).

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
22	Polgooth United	3	17	3	8	180	10	6
23	Prosper and Michell	11	6	0	6	621	18	9
24	St. Stephen's Tin and Copper	16	18	3	2	983	9	5
25	Tregeagle	7	16	0	0	705	0	0
26	Tregoss	0	17	3	20	50	0	0
27	Tretoil	12	5	0	6	625	0	0
28	Treworlis	25	14	0	17	1,373	15	11
	Total	985	8	3	17	56,001	3	10

Eastern District.

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Arthur Huel	5	7	0	1	269	7	2
2	Drake Walls	131	2	1	4	6,575	0	0
3	Emmens United (Redmoor)	1	17	0	25	98	6	5
4	Hawkmoor West	3	12	3	23	207	0	7
5	Hobb's Hill	12	5	0	15	547	15	0
6	Kit Hill South	4	14	2	27	209	12	3
7	Kit Hill United	4	14	2	27	209	12	3
8	Marke Valley	1	10	2	11	73	19	2
9	New Great Consols	50	14	1	2	2,632	8	6
10	Phœnix	312	7	1	8	16,012	12	2
11	Phœnix West	85	3	1	3	4,452	11	1
12	Phœnix South	5	12	1	6	249	4	2
13	Prince of Wales	3	17	1	20	190	4	7
14	Vincent Huel	15	5	2	10	768	2	11
	Total	637	18	3	14	32,495	16	3

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Bedford United	953	9	0	0	3,442	7	1
2	Birch Tor New	22	15	1	1	1,039	0	0
3	Bottle Hill Old	4	16	3	24	256	5	0
4	Furze Hill	53	15	0	0	3,031	12	3
5	Gem	1	11	3	20	87	16	1
6	Gobbet	1	10	1	20	85	0	0
7	Hutchings Mary Huel	22	2	1	27	1,310	7	5
8	Maria and Fortescue West	1	1	3	4	47	0	0
9	White Works (*Lidford*)	18	0	0	0	820	0	0
10	Vitifer, East	4	0	1	20	236	13	8
	Total	1,082	20	1	4	10,356	1	6

MINES which have sold their Produce (Tin Stuff) in the *Stone*.

No.	Names of Mines.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Basset West	12,271	19	2	0	15,600	0	0
2	Bosworgey	75	10	0	0	152	3	5
3	Britain Huel	274	11	0	0	404	15	0
4	Buller Huel	71	5	2	0	214	9	9
5	Busy Great Huel	134	19	2	0	84	11	9
6	Busy North Huel United	50	1	0	0	22	6	0
7	Calvadnack	11	19	0	0	63	2	0
8	Cathedral	2	3	3	0	9	8	6
9	Comford Huel	94	16	0	0	55	10	0
10	Creegbraws and Penkivill	91	19	1	0	165	4	0
11	Dolcoath New	164	13	3	0	67	18	0
12	Grambler Huel	910	8	3	0	104	18	6
13	Grenville East	25	3	3	11	32	0	0
14	Jane, North	3	1	2	0	22	3	4
15	Jane West Huel	3,672	15	0	0	1,150	0	0
16	Jewell West Huel	39	13	0	0	156	5	3
17	Killefreth	394	9	3	0	921	15	0
18	Lucy Huel	10	0	0	0	37	10	0
19	Maria Huel	128	2	0	0	91	13	6
20	Mitchell Huel	56	0	0	0	56	19	10
21	Nangiles	400	0	0	0	145	0	0
22	Osborne Huel	10	0	0	0	15	0	0
23	Peevor Huel	933	0	2	0	1,539	7	6
24	Perseverance	154	3	2	0	115	0	0
25	Poldice West	64	7	3	0	150	0	0
26	Prussia Huel, Redruth	432	2	2	0	275	10	0
27	Rosewarne North	2	6	3	0	7	9	7
28	Rosewarne United	32	9	3	0	24	7	5
29	Roskear West	84	19	1	0	64	19	0
30	Rocks and Goonbarrow	100	0	0	0	145	6	0
31	Rose United	41	19	2	0	19	0	6
32	Seton East Huel	50	0	0	0	27	16	0
33	St. Agnes Consols	50	0	0	0	92	0	0
34	St. Aubyn United	226	0	0	0	149	15	2
35	Tamping Quarry	120	0	0	0	90	0	0
36	Trebarvah	18	0	0	10	27	15	0
37	Treleigh Wood United	42	6	3	0	23	11	0
38	Tresavean	388	7	3	0	592	4	0
39	Sundry small quantities of Black Tin obtained from the waste heaps of abandoned mines, and sold in "the stone" (*Estimated*)	150	0	0	0	125	0	0
23	Total	21,783	3	0	21	23,041	15	0

STREAM-WORKS, RIVERS, and FORESHORES from which Black Tin has been obtained making returns to the Stannary Court, to the Duchy of Cornwall, or to the Mining Record Office:—

No.	Names of Streams.	Quantities.				Value.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Bushorne Streams	6	8	0	10	285	5	2
2	Cligga Porth	0	1	3	5	6	3	10
3	Darley Leat	6	9	2	1	336	14	7
4	Excelsior Stream	4	8	3	14	203	14	9
5	Helston Stream	4	14	0	0	256	0	0
6	Letcha Foreshore	0	19	2	19	60	4	9
7	Looe Pool Stream	4	14	3	7	178	13	8
8	Menadarva Stream	9	13	3	11	434	18	2
9	Mill Tin Stream	4	12	1	25	202	12	0
10	Nancemellin Streams	3	15	3	5	178	16	6
11	Restronguet Stream	16	11	1	10	747	10	0
12	Red River (Josiah Rogers)	4	12	3	17	179	0	0
13	Red River (Wm. Bond)	10	5	1	10	423	2	8
14	Red River (Edw. Dunn)	1	2	0	9	60	14	4
15	Roscroggan Stream	18	13	0	18	771	2	0
16	River between Goonlaze and Ty Tyas	0	5	0	13	14	2	0
17	Tolvadden Stream	47	4	3	18	2,218	3	2
18	Trevaunance Stream	4	12	0	9	218	1	7
19	Trevellas Beach	0	9	2	8	19	2	10
	Total	146	6	1	3	6,794	2	0

RED RIVER AND OTHER RIVERS.

No.	Proprietors.	Value of Tin.		
		£	s.	d.
1	Clymo and Treloar	13	0	0
2	Excelsior Company	25	0	0
3	William Goldsworthy, Tolvadden	29	0	0
4	Richard Perry, Rosewarne	220	0	0
5	R. S. Evans, Menadarva	45	0	0
6	Evans and Dale, Menadarva	19	0	0
7	Rescadinnick Stream Company	417	0	0
8	Trevarnoe Stream Company	135	0	0
9	Joseph Jewell, Blowing-house	94	0	0
10	Gilbert Chappel, Kieve Mills	79	0	0
11	Magor Coombe Tin Stream Company	132	0	0
12	South Nancemellan Stream Company	16	0	0
13	Entral Tin Stream Company	15	0	0
14	Gwithian Beach—Captain Williams	158	0	0
	Total in Camborne	1,397	0	0

RED RIVER AND OTHER RIVERS—(*Continued*).

No.	Proprietors.	Value of Tin.		
		£	s.	d.
1	John Hocking, Portreath	3	0	0
2	Richard Pearce, Pool	8	0	0
3	Stephen Evans & Co., Portreath	6	0	0
4	Joseph Jewell and Co., Menadarva	27	0	0
5	John Winn & Co., Harris's Mill	82	0	0
6	Fox, Penberthy, & Co.	16	0	0
7	James Evans, Whitefield	159	0	0
8	John Dawe, Bridge	168	0	0
9	Bracket Company	5	0	0
10	C. Harris	3	0	0
11	Bridge Company	7	0	0
	Total in Illogan	484	0	0

DUCHY OF CORNWALL.

QUANTITY and VALUE of TIN ORE raised in CORNWALL upon which Dues were paid to the Duke of Cornwall:—

No.	Names of Mines and Streams.	Quantity.				Amount realized.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
1	Phœnix	405	19	2	25	21,922	10	5
2	South Phœnix	10	5	2	9	586	13	10
3	West Phœnix	88	8	3	9	4,774	15	0
4	Darley Leat	6	9	2	1	336	14	7
5	Kit Hill United	4	14	2	27	209	12	3
6	New Great Consols	138	18	3	24	8,232	14	11
7	Wheal Prudence	0	7	3	0	14	4	2
8	Polberro Consols	66	14	1	16	3,996	14	8
9	Scorrier Consols	6	17	2	10	338	14	7
10	River between Goonlaze and Ty Tyas	0	5	0	13	14	2	0
11	Clegga or Cligga Porth	0	1	3	5	6	3	10
12	Wheal Coit and Wheal Friendly Stamping Mills.	17	11	0	24	903	18	9
13	Blue Hills	70	5	2	2	4,200	10	1
14	Drakewalls	87	8	1	21	4,818	19	6
15	Wheal Arthur	5	7	0	1	269	7	2
16	Hawkmoor or West Hawkmoor	3	12	3	23	207	0	7
17	Prince of Wales	3	17	1	20	190	4	7
18	Charlestown United Mines	109	13	3	21	6,659	8	11
19	Treworlis	25	14	0	17	1,373	15	11
20	Galidna or North Lovell	1	12	1	3	110	17	0
21	Looe Pool Stream Grant	2	0	1	7	70	11	0
22	New or South Wheal Lovell	17	14	1	1	1,115	7	4
23	Helston Stream Works	4	14	0	0	256	0	0
24	East Wheal Lovell	92	2	0	21	5,516	5	7
25	Trumpet Consols	44	19	0	9	3,089	16	6
26	Balmynheer	95	15	1	20	6,318	12	0
27	Trevaunance Stream	4	12	0	9	218	1	7

DUCHY OF CORNWALL—(*Continued*).

No.	Names of Mines and Streams.	Quantity.				Amount realized.		
		Tons.	cwts.	qrs.	lbs.	£	s.	d.
28	Letcha Foreshore	0	19	2	19	60	4	9
29	Trevallas Beach	0	9	2	8	19	2	10
30	St. Just Amalgamated	32	3	1	0	2,022	1	10
	FROM THE CROWN.							
31	Wheal Castle	154	16	1	18	1,988	5	0
32	Botallack	19	10	3	5	1,507	16	11
	Total	1,524	3	3	24	81,349	8	1

STATEMENT of BANCA TIN sold at Auction by the Dutch Trading Company, and the Prices realized since 1857:—

Years.	Slabs.	Tons.	Value.		
			£	s.	d.
1857	190,559	6,098	140	10	0
1858	190,842	6,110	116	0	0
1859	139,128	4,453	141	0	0
1860	151,513	4,850	136	0	0
1861	149,188	4,775	118	0	0
1862	155,193	4,968	115	10	0
1863	119,092	3,812	130	0	0
1864	146,921	4,704	106	0	0
1865	167,800	5,370	96	0	0
1866	221,100	7,172	84	10	0
1867	140,400	4,496	94	10	0
1868	152,000	4,864	95	10	0
1869	110,800	3,645	135	0	0
1870	156,800	5,018	128	0	0
1871	164,000	5,248	132	0	0
1872	99,300	3,176	161	0	0
1873	135,200	4,325	134	0	0
1874	128,000	4,096	123	0	0

N.B.—1000 slabs of Banca weigh 32 tons English.

PRODUCTION of the DUTCH TIN MINES since 1855.

Years.	Banca.		Billiton.	
	Slabs.	Tons.	Slabs.	Tons.
1855	128,256	4,233	2,734	97
1856	201,317	6,643	6,714	238
1857	149,336	4,928	3,674	130
1858	192,950	6,367	9,014	320
1859	181,968	6,005	4,620	164
1860	165,620	5,465	8,000	284
1861	173,008	5,709	13,018	462
1862	141,770	4,678	10,182	361
1863	191,963	6,334	20,636	732
1864	161,916	5,343	22,380	794
1865	138,012	4,554	30,000	1,065
1866	158,626	5,234	33,000	1,171
1867	140,570	4,639	65,940	2,341
1868	120,000	3,960	60,600	2,151
1869	135,868	4,483	68,291	2,424
1870	146,000	4,672	89,283	2,858
1871	134,906	4,320	90,700	3,190
1872	136,000	4,352	108,000	3,456
1873	126,000	4,480	102,000	3,264
1874	154,000	4,930	126,000	4,032

N.B.—Banca tin is produced by convict labour in the Island of Banca, from whence it is sent across to the port of Batavia, in Java, for shipment to Rotterdam, where it is warehoused and sold periodically by the Trading Company. Billiton tin is raised by a private company in the Dutch Island of Billiton, sometimes sold on the spot, and sometimes sent to Holland for sale.

AVERAGE PRICES of TIN and TIN-PLATES in London since 1857.

Years.	Banca.		Straits.		Refined.		Charcoal Tin-Plates.		Coke Tin-Plates.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d*
1857	140	7	137	0	141	5	40	0	33	1
1858	117	7	116	0	122	10	32	11	26	3
1859	136	1	132	7	136	7	32	4	26	3
1860	136	6	131	3	138	8	31	6	25	10
1861	122	9	119	3	124	9	29	9	23	3
1862	120	5	116		120	0	28	5	23	3
1863	124	2	120	6	122	0	29	1	23	7
1864	107	8	106	1	111	3	30	4	26	4
1865	95	10	92	5	98	7	29	10	24	5
1866	85	2	82	6	92	4	33	2	27	9
1867	91	7	88	0	93	5	31	3	25	0
1868	95	2	93	8	99	7	27	1	21	8
1869	128	6	126	3	129	9	28	3	23	10
1870	126	8	124	2	129	8	28	10	24	1
1871	135	2	133	6	139	4	29	8	25	6
1872	153	0	145	11¾	155	1½	42	1¾	36	10
1873	135	3	133	3	137	9	42	1	34	1
1874	102	5	98	6	104	0	37	6	29	11

IMPORTS of TIN and TIN ORE in the Year 1874.

Countries from which Imported.	Tin Ore.	Tin.
	Tons.	Tons.
Holland	1	452
France	31	40
Portugal	11	3
Spain	23	..
Egypt	..	27
British India	5	33
Straits Settlements	1	4,177
Australia: Victoria	672	1,106
„ New South Wales	1,915	2,293
„ Queensland	975	620
„ Tasmania	60	..
„ New Zealand	34	5
Peru	535	367
Bolivia	13	50
Chili	28	43
Other Parts	1	2
Total Import . . . . . Tons	4,305	9,218

EXPORTS of BRITISH and FOREIGN TIN in the Year 1874.

Countries to which Exported.	British.	Foreign.	Total.
	Tons.	Tons.	Tons.
Russia: Northern Ports	621	15	637
„ Southern Ports	135	9	144
Sweden	112	15	127
Norway	33	..	33
Denmark	74	..	74
Germany	1,014	136	1,150
Holland	268	290	558
Belgium	55	36	91
France	1,537	587	2,124
Portugal, Azores, and Madeira	77	..	77
Spain	200	68	268
Gibraltar	5	..	5
Italy	118	211	329
Austrian Territories	5	40	45
Malta	5	..	5
Greece	38	..	38
Turkey: European	333	..	333
„ Asiatic	115	3	118
Wallachia and Moldavia	51	..	51
Egypt	60	..	60
Morocco	5	..	5
British Possessions in South Africa	6	..	6
British India: Continental Territories	20	8	28
Australia: South Australia	12	..	12

IMPORTS of TIN and TIN ORE in the Year 1874—(*Continued*).

Countries to which Exported.	British.	Foreign.	Total.
	Tons.	Tons.	Tons.
Australia: Victoria	4	..	4
„ New Zealand	9	..	9
British North America	154	4	158
United States of America: On the Atlantic	2,519	882	3,401
„ „ On the Pacific	10	78	88
British West India Islands and British Guiana	7	..	7
Foreign West Indies	8	..	8
United States of Colombia (New Granada)	7	..	7
Chili	4	..	4
Brazil	52	..	52
Uruguay	23	..	23
Argentine Republic	13	..	13
Other Parts	22	..	22
Total Export . . Tons	7,731	2,382	10,113

EXPORTS of TIN of British Production in the Year 1874, and two previous Years, as per Board of Trade Returns.

Countries to which Exported.	Tin, Unwrought.			Declared Value.		
	1872.	1873.	1874.	1872.	1873.	1874.
	Cwts.	Cwts.	Cwts.	£	£	£
To Russia	12,399	16,959	14,728	92,497	114,238	76,112
„ Germany	14,921	12,600	20,280	115,369	84,893	105,485
„ France	30,097	19,804	31,053	216,156	133,309	171,183
„ Turkey	9,500	7,650	8,961	73,255	51,897	46,002
„ United States	18,983	29,958	50,803	141,943	210,656	265,613
„ Other Countries	27,971	28,179	29,243	211,862	191,163	148,910
Total	113,871	115,150	155,068	851,082	786,156	813,305

The following figures are taken from a Table prepared by Joseph Carne, Esq., F.R.S., and published in the *Journal of the Statistical Society* in 1839:—

Quantities of Banca Tin brought to Holland in each year from 1760 to 1789.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1760	324	1770	210	1780	310
1761	185	1771	311	1781	none
1762	325	1772	457	1782	44
1763	369	1773	210	1783	136
1764	60	1774	311	1784	372
1765	279	1775	390	1785	310
1766	146	1776	256	1786	195
1767	167	1777	250	1787	543
1768	311	1778	262	1788	80
1769	457	1779	409	1789	40

PRODUCTION in CORNWALL 1750–1838, with EXPORTS and IMPORTS.

Years.	Produced in Cornwall.	Exported from United Kingdom.	Import of Foreign.	Years.	Produced in Cornwall.	Exported from United Kingdom.	Import of Foreign.
	Tons.	Tons.	Tons.		Tons.	Tons.	Tons.
1750	2,876	..	..	1795	3,440	3,004	..
1751	2,273	..	..	1796	3,061	2,756	..
1752	2,550	..	..	1797	3,240	1,840	..
1753	2,516	..	..	1798	2,820	2,214	..
1754	2,724	..	..	1799	2,862	1,713	..
1755	2,757	..	..	1800	2,522	1,782	..
1756	2,774	..	..	1801	2,365	1,721	..
1757	2,752	..	..	1802	2,686	1,663	..
1758	2,720	..	..	1803	2,960	1,553	..
1759	2,637	..	..	1804	3,041	1,949	..
1760	2,717	..	..	1805	2,785	1,641	..
1761	2,395	..	..	1806	2,905	1,415	..
1762	2,584	..	..	1807	2,465	1,229	..
1763	2,736	..	..	1808	2,371	1,469	..
1764	2,618	..	..	1809	2,548	1,500	..
1765	2,757	..	..	1810	2,036	825	..
1766	3,055	..	..	1811	2,385	862	..
1767	2,850	..	..	1812	2,373	1,444	..
1768	2,667	..	..	1813	2,324	..	..
1769	2,898	..	..	1814	2,611	993	..
1770	2,977	..	..	1815	2,941	1,442	325
1771	2,823	..	..	1816	3,348	1,998	275
1772	3,159	..	..	1817	4,120	2,660	235
1773	2,852	..	..	1818	4,066	1,771	72
1774	2,458	..	..	1819	3,315	1,506	15
1775	2,619	..	..	1820	2,990	1,444	65
1776	2,652	..	..	1821	3,373	1,493	55
1777	2,770	..	..	1822	3,278	1,888	77
1778	2,515	..	..	1823	4,213	1,593	323
1779	2,678	..	..	1824	5,005	1,079	219
1780	2,928	..	..	1825	4,358	1,947	211
1781	2,610	..	..	1826	4,603	2,464	170
1782	2,546	..	..	1827	5,555	2,621	111
1783	2,570	1,690	..	1828	4,931	2,234	169
1784	2,685	1,564	..	1829	4,434	1,790	134
1785	2,885	2,002	..	1830	4,444	2,042	776
1786	3,399	2,348	..	1831	4,300	1,699	405
1787	3,204	2,230	..	1832	4,323	2,678	1,460
1788	2,352	2,322	..	1833	4,065	3,241	1,756
1789	3,405	2,215	..	1834	2,989	2,802	2,338
1790	3,193	2,910	..	1835	4,228	1,578	985
1791	3,470	2,618	..	1836	4,054	1,419	1,162
1792	3,809	2,884	..	1837	4,790	2,325	1,455
1793	3,202	1,981	..	1838		2,705	1,536
1794	3,351	2,312	..				

The following STATEMENT, showing the Production, Import, Export, and Consumption of English and Foreign Tin, has been prepared by the Author year by year as the figures appeared from 1860 to 1875:—

	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
London Warehoused Stock, January 1st	696	410	1,576	2,293	2,612	3,646	2,936	3,168
Produced in Cornwall during the year	6,695	7,450	9,400	10,100	10,108	10,039	9,990	8,700
Import—Foreign and Colonial	2,911	3,653	4,394	2,728	4,905	5,698	5,523	5,429
Total United Kingdom supply . . Tons	10,302	11,513	15,370	15,121	17,625	19,383	18,449	17,297
Consumed in the United Kingdom	6,644	6,146	7,890	6,993	8,127	9,258	9,935	9,522
Export—British and Foreign	3,248	3,791	5,187	5,516	5,852	7,189	5,346	5,519
London Warehoused Stock, December 31st	410	1,576	2,293	2,612	3,646	2,936	3,168	2,256
Total disposed of . . . Tons	10,302	11,513	15,370	15,121	17,625	19,383	18,449	17,297
DETAIL OF ENGLISH TIN.								
English Produced	6,695	7,450	9,400	10,100	10,108	10,139	9,990	8,700
English Exported	2,740	2,833	4,104	4,381	4,457	5,185	4,293	4,191
English Consumed . . . . Tons	3,955	4,617	5,296	5,719	5,651	4,854	5,697	4,509
DETAIL OF FOREIGN TIN.								
Foreign Imported	2,911	3,653	4,394	2,728	4,905	5,698	5,523	5,429
Foreign Exported	508	958	1,083	1,135	1,395	2,004	1,053	1,328
Foreign available for use . . Tons	2,403	2,695	3,311	1,593	3,510	3,694	4,470	4,101

STATEMENT, showing the Production, Import, Export, and Consumption of English and Foreign Tin—*continued.*

	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.
London Warehoused Stock, January 1st.	2,256	1,665	1,916	739	1,286	786	2,038	2,895
Produced in Cornwall during the year	9,300	9,700	10,250	10,500	10,250	9,500	9,700	9,500
Import—Foreign and Colonial.	5,625	5,000	4,715	8,500	8,300	10,600	11,400	16,700
Total United Kingdom supply . . Tons	17,181	16,365	16,881	19,739	19,836	20,886	23,138	29,095
Consumed in the United Kingdom	10,286	8,243	9,903	10,853	10,800	11,598	10,243	13,845
Export—British and Foreign.	5,230	6,206	6,239	7,600	8,250	7,250	10,000	9,750
London Warehoused Stock, December 31st	1,665	1,916	739	1,286	786	2,038	2,895	5,500
Total disposed of . . . Tons	17,181	16,365	16,881	19,739	19,836	20,886	23,138	29,095
DETAIL OF ENGLISH TIN.								
English Produced	9,000	9,700	10,250	10,500	10,250	9,500	9,700	9,500
English Exported	4,125	5,094	5,140	5,500	5,750	5,500	7,750	5,250
English Consumed . . . . Tons	4,875	4,606	5,110	5,000	4,500	4,000	1,950	4,250
DETAIL OF FOREIGN TIN.								
Foreign Imported	5,625	5,000	4,715	8,500	8,300	10,600	9,250	16,700
Foreign Exported	1,105	1,112	1,098	2,100	2,500	1,750	2,250	4,500
Foreign available for use . . Tons	4,520	3,888	3,617	6,400	5,800	8,850	7,000	12,200

Summary of Exports.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
Foreign Tin Exported	508	958	1,083	1,135	1,395	2,004	1,053	1,328
English do. Exported	2,740	2,833	4,104	4,381	4,457	5,185	4,293	4,191
Total Exported . . . . Tons	3,248	3,791	5,187	5,516	5,852	7,189	5,346	5,519
Summary of Consumption.								
English Consumed	3,955	4,617	5,296	5,719	5,651	4,854	5,697	4,509
Foreign do.	2,689	1,529	2,594	1,274	2,476	4,404	4,238	5,013
Total Consumption . . . Tons	6,644	6,146	7,890	6,993	8,127	9,258	9,935	9,522
Total Available Supply.								
Banca Sold by Auction in Holland	4,980	4,813	5,006	3,841	4,739	5,420	7,132	4,520
Produce of the Billiton Mines	252	150	116	7	414	536	714	1,095
Straits from Singapore and Penang	4,529	4,343	3,931	3,060	4,364	6,076	5,300	7,069
English raised in Cornwall	6,695	7,450	9,400	10,100	10,108	10,039	9,990	8,700
Total Supply . . . . . Tons	16,456	16,756	18,453	17,008	19,625	22,071	23,136	21,385
Total Available Stock.								
Foreign Floating and Warehoused	1,284	2,844	2,913	3,214	4,702	5,160	3,855	3,224
Banca Warehoused only	4,641	4,103	4,247	4,145	4,719	6,149	6,310	6,021
Billiton Floating and Warehoused	206	..	59	7	115	200	513	519
Total Stock, December 31st . . Tons	6,131	6,947	7,219	7,366	9,536	11,509	10,678	9,564

STATEMENT, showing the Production, Import, Export, and Consumption of English and Foreign Tin—*continued.*

SUMMARY OF EXPORTS.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.
Foreign Tin Exported	1,105	1,112	1,098	2,100	2,500	1,750	2,250	4,500
English do. Exported	4,125	5,094	5,141	5,500	5,750	5,500	7,750	5,250
Total Exported . . . . Tons	5,230	6,206	6,239	7,600	8,250	7,250	10,000	9,750
SUMMARY OF CONSUMPTION.								
English Consumed	4,875	4,606	5,110	5,000	4,500	4,000	1,950	4,250
Foreign do.	5,411	3,637	4,793	5,853	6,300	7,598	8,293	9,595
Total Consumption . . . Tons	10,286	8,243	9,903	10,853	10,800	11,598	10,243	13,845
TOTAL AVAILABLE SUPPLY.								
Australian	..	..	..	..	..	3,000	6,000	7,200
Banca sold by Auction in Holland	3,052	3,585	5,058	5,293	3,203	4,355	4,000	4,400
Produce of the Billiton Mines	1,305	1,737	1,593	2,700	2,947	2,980	3,157	3,500
Straits from Singapore and Penang	6,300	5,442	6,043	9,100	9,600	6,800	7,149	11,000
English raised in Cornwall	9,300	9,700	10,150	10,500	10,250	9,500	7,500	9,500
Total Supply . . . . . Tons	19,957	20,464	22,844	27,593	26,000	26,635	30,006	35,600
TOTAL AVAILABLE STOCK.								
Foreign Floating and Warehoused	2,665	2,758	1,354	2,157	1,601	2,548	4,475	8,065
Banca Warehoused only	4,581	3,988	4,715	2,075	3,155	4,205	4,226	3,050
Billiton Floating and Warehoused	22	132	632	219	750	1,175	1,703	1,570
Total Stock, December 31st . Tons	7,268	6,878	6,701	4,451	5,506	7,928	10,404	12,685

TIN-PLATE STATISTICS.

The author is solely responsible for the following statistics and information, which have been collected and arranged with some difficulty.

In grouping the several works for date of construction it is *possible* that some of the earlier built works have been classed a few years sooner or later than the dates which have been named for them: however, taken as a whole, they are certainly for all practical purposes correct. The origin of the trade at Pontypool in 1670 is now we hope placed beyond doubt; and the list of works as existing in 1875 may be relied upon as a certain guide to the present position and production of the Tin-plate Trade.

The statistics of export have been extracted and arranged by the Author from the unbusiness-like returns which are issued from the offices of Her Majesty's Customs.

Works existing in	1750.	1800.	1825.	1850.	1860.	1865.	1870.	1875.
Monmouthshire	2	4	6	11	12	12	15	16
Carmarthenshire	2	2	2	3	4	5	8	14
Glamorganshire	..	2	4	8	12	15	19	27
Staffordshire	..	..	1	7	7	8	9	9
Worcestershire	..	..	1	2	2	3	3	3
Herefordshire	..	1	1	1	1	1	1	1
Flintshire	..		..	..	..	..	1	2
Gloucestershire	..		1	1	1	1	1	1
Cumberland	..		..	1	1	1	1	1
Scotland	..		..	..	..	1	1	1
Total Works	4	9	16	34	40	47	59	75

Estimate of production . . . 3,000,000 Boxes per Annum.

Name of Works.	County.	Date of Construction.
Pontypool	Monmouth	1675
Kidwelly	Carmarthen	1720
Pontlin	Monmouth	1747
Carmarthen	Carmarthen	1750
Pentyrch	Glamorgan	1750 to 1800
Redbrook	Monmouth	ditto
Lydbrook	Hereford	ditto
Caerleon	Monmouth	ditto
Ymspenllwch	Glamorgan	ditto

Name of Works.	County.	Date of Construction.
Rugeley	Staffordshire	1800 to 1825
Pontnewydd	Monmouth	ditto
Pontrhyderyn	Monmouth	ditto
Coolley	Worcester	ditto
Lydney	Gloucester	ditto
Margam	Glamorgan	ditto
Cairn-avon	Glamorgan	ditto
Machen	Monmouth	1825 to 1840
Tydee	Monmouth	ditto
Aberdulais	Glamorgan	ditto
Bradley	Stafford	ditto
Pontardawe	Glamorgan	ditto
Treforest	Glamorgan	ditto
Horsley Fields	Stafford	ditto
Broadwallis	Stafford	ditto
Brierhed	Stafford	ditto
Welden	Stafford	ditto
Pontymister	Monmouth	1840 to 1850
Brockmore	Stafford	ditto
Tividale	Stafford	ditto
Upper Forest	Glamorgan	ditto
Abercarne	Monmouth	ditto
Abertillery	Monmouth	ditto
Dafen	Carmarthen	ditto
Derwent	Cumberland	ditto
Landore	Glamorgan	1850 to 1860
Morfa	Carmarthen	ditto
Istalyfera	Glamorgan	ditto
Parlmee	Monmouth	ditto
Beaufort	Glamorgan	ditto
Cairn-felyn	Glamorgan	ditto
Vernon	Glamorgan	1860 to 1865
Hope	Stafford	ditto
Cairnhourla	Glamorgan	ditto
Coathridge	Scotland	ditto
Melyn	Glamorgan	ditto
Stone Vale	Worcester	ditto
Maisefield	Carmarthen	ditto
Star	Stafford	1865 to 1870
Avon Vale	Glamorgan	ditto
Garth	Monmouth	ditto
Hendy	Carmarthen	ditto
Llangenneck	Carmarthen	ditto
Old Castle	Carmarthen	ditto
Llarydarth	Glamorgan	ditto
Worcester	Glamorgan	ditto
Holywell	Flintshire	ditto
Gadly	Glamorgan	ditto
Monmouth	Monmouth	ditto
Abergavenny	Monmouth	ditto

Name of Works.	County.	Date of Construction.
Amman	Glamorgan	1870 to 1875
Gower	Glamorgan	ditto
Cambria	Carmarthen	ditto
Isfully	Carmarthen	ditto
Morlais	Carmarthen	ditto
South Wales	Carmarthen	ditto
Dyffryn	Glamorgan	ditto
Mold	Flint	ditto
Pontardulais	Glamorgan	ditto
Mansel	Glamorgan	ditto
Llantrissant	Glamorgan	ditto
Marnstan	Glamorgan	ditto
Tynewydd	Monmouth	ditto
Bunows	Glamorgan	ditto
Glamorgan	Carmarthen	ditto
Bing	Carmarthen	ditto

A List of the French Tin-plate Works, with their approximative Production in Tin and Terne Plates in 1874.

Names of the Firms.	Addresses of the Works.	Approximative Production of Tin and Terne Plates.
		Boxes.
Société anonyme des Forges et Fonderies de Montataire	Montataire (Oise)	80,000
Compagnie des Forges de Châtillon et Commentry	Commentry (Allier)	70,000
Trottier frères et Cie.	Hennebont (Morbihan)	70,000
Campionnet et Cie.	Gueugnon (Saône-et-Loire)	30,000
Vve. Th. Chavanne	Bains (Vosges)	10,000
De Buyer	La Chaudeau (Hte. Saône)	10,000
Société anonyme des Hauts-Fourneaux, Fonderies et Forges de Franche-Comté	Bourg-de-Sirod (Jura)	10,000
Perraudin et Cie.	Le Verderat (Saône-et-Loire)	10,000
Vor. de Pruynes	Semouse (Vosges)	6,000
Société anonyme des Usines de Gouille	Gouille, près Besançon (Doubs)	6,000
Compagnie des Forges d'Audincourt et Dépendances	Audincourt (Doubs)	2,000
		304,000

PRICES of BEST CHARCOAL and COKE TIN-PLATES—*1st January*, 1876.

Mark.	Size.	Sheets.	Weight.	Best Charcoal.	Best Coke.	Coke.	Wasters.
IC . .	14×10	225	1 0 0	28*s.*	26*s.*	24*s.*	2*s.* per Box less.
IX . .	„ „	„	1 1 0	34*s.*	32*s.*	30*s.*	3*s.* „
IXX . .	„ „	„	1 1 21	40*s.*	38*s.*	36*s.*	3*s.* „
IXXX .	„ „	„	1 2 14	46*s.*	44*s.*	42*s.*	6*s.* „
IXXXX.	„ „	„	1 3 7	52*s.*	50*s.*	48*s.*	6*s.* „
DC . .	17×12½	100	0 3 14	24*s.*	22*s.*	20*s.*	2*s.* „
DX . .	„ „	„	1 0 14	30*s.*	28*s.*	26*s.*	3*s.* „
DXX. .	„ „	„	1 1 7	36*s.*	34*s.*	32*s.*	6*s.* „
DXXX .	„ „	„	1 2 0	42*s.*	40*s.*	38*s.*	6*s.* „
DXXXX	„ „	„	1 2 21	48*s.*	46*s.*	44*s.*	6*s.* „
SDC . .	15×11	200	1 1 27	50*s.*	48*s.*	...	6*s.* „
SDX . .	„ „	„	1 2 20	56*s.*	54*s.*	..	6*s.* „
SDXX .	„ „	„	1 3 13	62*s.*	60*s.*	..	6*s.* „
SDXXX	„ „	„	2 0 6	68*s.*	66*s.*	..	6*s.* „
SDXXXX	„ „	„	2 0 27	74*s.*	72*s.*	..	6*s.* „

Double Lengths and Double Widths, 1*s.* per Box extra.
Irregular sizes at special rates.

August, 1873.

FACTORY PRICES of PLAIN WHITE and BLACK TIN-PLATES of the Iron Works of His Excellency the Duke of Erweinvlostz, Rothau, Bohemia.

These Prices are understood to be for goods delivered at our depôts in Prague without obligation if prices are changed.

Bills payable at Prague, four-month acceptances, or 2 per cent. for cash.

ENGLISH TINNED, WHITE TIN-PLATES.

					Austrian currency. flor.	kr.
FF. .	13 in. broad,	20 in. long,	185–190 lbs.,	150 sheets per box	50	—
F . .	13 „ „	20 „ „	„ „ „	„ „ „	49	50
A . .	13 „ „	20 „ „	„ „ „	„ „ „	49	—
AA .	13 „ „	20 „ „	„ „ „	„ „ „	47	50
WF .	13 „ „	20 „ „	155–160 „	„ „ „	46	50
WFF .	13 „ „	20 „ „	140–150 „	„ „ „	45	50
FFH .	9¾ „ „	26 „ „	185–190 „	„ „ „	50	—
FH .	9¾ „ „	26 „ „	„ „ „	„ „ „	49	50
AH .	9¾ „ „	26 „ „	„ „ „	„ „ „	49	..
FF. .	9¾ „ „	13 „ „	180–190 „	300 „ „	..	
F . .	9¾ „ „	13 „ „	„ „ „	„ „ „	..	
A . .	9¾ „ „	13 „ „	„ „ „	„ „ „	..	
FF. .	9¾ „ „	14 „ „	185–190 „	„ „ „	51	..
F . .	9¾ „ „	14 „ „	„ „ „	„ „ „	50	50
A . .	9¾ „ „	14 „ „	„ „ „	„ „ „	50	..

ENGLISH TINNED, WHITE TIN-PLATES FOR TINSMITHS.

								Austrian currency. flor.	kr.
WS	. 9¾	in. broad,	13	in. long,	80–90	lbs.	300 sheets per box.	44	25
WS	. 9¾	„	14	„	„	„	„	..	
WS	. 10	„	14	„	90–95	„	„	44	75

Wholesale dealers extra 5 per cent. Discount 2 per cent. = per cent.

SOCIÉTÉ ANONYME des FORGES et FONDERIES de MONTATAIRE.—Siége social et entrepôt: rue Béranger 21 (ancienne rue Vendôme), à Paris.

15 septembre 1872.—Tarif des fers-blancs brillants, ternes et inoxydables, et des tôles étamées.

Conditions de payement: quatre mois de terme ou 2% au comptant.

Fers-blancs brillants, fer fort, qualité dite Étoile.—(Marque *.)

Marques.	Dimensions.	Poids approximatif.	Prix.		
			choix mêlés.	3e choix W	
	millimètres.	kilogr. environ.	fr.	fr.	
C Clinquant.	325 sur 244	15 à 19	46	43	
C Id.	Id.	20 à 25	44	41	
SB . . .	Id.	31	40	39	La caisse de 150 feuilles.
XB . . .	Id.	37	44	40	
XXB . .	Id.	43	48	43	
XXXB . .	Id.	49	52	46	
SB . Dble..	325 sur 488	31	40	39	
XB . . .	Id.	37	44	40	La caisse de 75 feuilles.
XXB . .	Id.	43	48	43	
XXXB . .	Id.	49	52	46	
C Clinquant.	352 sur 257	25	75	70	
C Id.	Id.	28	71	66	
C Id.	Id.	38	66	60	
ICB . . .	Id.	53	68	65	La caisse de 225 feuilles.
IXB . . .	Id.	65	76	68	
IXXB . .	Id.	75	84	75	
IXXXB .	Id.	85	92	82	
IXXXXB .	Id.	95	100	88	
ICB Dble .	352 sur 514	53	68	65	
IXB . . .	Id.	65	76	68	La caisse de 112 feuilles.
IXXB . .	Id.	75	84	75	
IXXXB .	Ip.	85	92	82	
SDCB . .	379 sur 284	64	84	77	
SDXB . .	Id.	74	92	82	La caisse de 200 feuilles.
SDXXB .	Id.	84	100	88	
SDXXXB .	Id.	94	108	92	

" Fers-blancs brillants fer fort—(*suite*).

Marques.	Dimensions.	Poids approximatif.	Prix. Choix mêlés.	Prix. 3e choix W.	
	millimètres.	kilogr. environ.	fr.	fr.	
MCB . .	406 sur 311	62	82	75	La caisse de 150 feuilles.
MXB . .	Id.	74	90	80	
MXXB . .	Id.	86	98	86	
MXXXB .	Id.	98	106	90	
DCB . .	433 sur 325	46	61	56	La caisse de 100 feuilles.
DXB . .	Id.	56	69	61	
DXXB . .	Id.	66	77	66	
DXXXB .	Id.	76	85	71	
IDCB . .	435 sur 258	63	82	78	La caisse de 225 feuilles.
IDXB . .	Id.	73	90	82	
IDXXB. .	Id.	83	98	87	
IDXXXB .	Id.	93	106	93	
CVB . (Pour boîtes à conserves.)	417 sur 251	58	75	71	La caisse de 225 feuilles.
CVBG .	420 sur 380	83	113	109	
CLB .	435 sur 236	58	75	71	
VB . .	428 sur 258	60	78	74	
CDB .	475 sur 240	62	81	77	
IDCB .	435 sur 258	63	82	78	
FCB .	345 sur 345	62	82	78	
FCB .	460 sur 260	62	82	78	
FCBG .	465 sur 350	83	113	109	
TFB .	445 sur 271	68	88	84	
TCB .	635 sur 228	86	112	105	
SLB. . .	1m sur 244	31	45	43	La caisse de 50 feuilles.
XLB . .	Id.	37	49	45	
XXLB . .	Id.	43	53	47	
XXXLB .	Id.	49	57	50	
DSLB . .	1m sur 325	42	64	57	La caisse de 50 feuilles.
DXLB . .	Id.	49	67	61	
DXXLB .	Id.	57	73	65	
DXXXLB .	Id.	65	79	68	
ICLB . .	1m sur 352	46	67	63	La caisse de 50 feuilles.
IXLB . .	Id.	54	73	67	
IXXLB. .	Id.	62	79	70	
IXXXLB .	Id.	72	85	74	
MCLB . .	1m sur 406	64	93	87	La caisse de 50 feuilles.
MXLB . .	Id.	76	101	93	
MXXLB .	Id.	88	109	99	
MXXXLB.	Id.	100	117	105	

Fers-blancs brillants supérieurs (marque SUP.).

Mêmes dimensions que celles ci-dessus.

6 francs de plus par 100 kilogrammes, en calculant sur le poids normal de la Caisse.

Toutes les sortes dont les dimensions ne sont pas comprises au présent Tarif se vendent au poids et aux prix suivants, le fer-blanc de plus de 0m 63 de long, étant classé comme long.

Epaisseurs.	Brillant, fer fort.				Brillant supérieur.			
	Choix mêlés.		W.		Choix mêlés.		W.	
	Court	Long	Court	Long	Court	Long	Court	Long
millimètres.	fr.	fr.	fr.	fr.	fr.	fr.	fr.	fr.
30/100 à 40/100 exclusivt.	138	148	128	138	146	156	136	146
40/100 à 50/100 exclusivt.	132	142	122	132	140	150	130	140
50/100 et au-dessus . .	125	135	115	125	133	143	123	133

Fers-blancs ternes ordinaires.

Marques.	Dimensions.	Poids approximatif.	Prix.		
			Choix mêlés.	3e Choix W.	
	millimètres.	kilogr. environ.	fr.	fr.	
ST . . .	325 sur 244	31	29	28	La caisse de 150 feuilles.
XT . . .	Id.	37	32	31	
XXT . .	Id.	43	36	34	
XXXT . .	Id.	49	39	36	
ST . Dble .	325 sur 488	31	29	28	La caisse de 75 feuilles.
XT . . .	Id.	37	32	31	
XXT . .	Id.	43	36	34	
XXXT . .	Id.	49	39	36	
ICT . . .	352 sur 257	53	52	48	La caisse de 225 feuilles.
IXT . . .	Id.	65	58	51	
IXXT . .	Id.	75	64	55	
IXXXT .	Id.	85	70	60	
ICT . Dble .	352 sur 514	53	52	48	La caisse de 112 feuilles.
IXT . . .	Id.	65	58	51	
IXXT . .	Id.	75	64	55	
IXXXT .	Id.	85	70	60	
DXT . .	433 sur 325	56	52	48	La caisse de 100 feuilles.
DXXT . .	Id.	66	58	52	
DXXXT .	Id.	76	64	55	
MCT . .	406 sur 311	62	59	54	La caisse de 150 feuilles.
MXT . .	Id.	74	66	60	
MXXT . .	Id.	86	73	65	
MXXXT .	Id.	98	80	69	

Fers-blancs ternes ordinaires—(*suite*).

Marques.	Dimensions.	Poids approximatif.	Prix. Choix mêlés.	Prix. 3e Choix W.	
	millimètres.	kilogr. environ.	fr.	fr.	
SLT . .	1m sur 244	31	31	30	La caisse de 50 feuilles.
XLT . .	Id.	37	34	33	
XXLT . .	Id.	43	38	35	
XXXLT .	Id.	49	41	37	
DSLT . .	1m sur 325	42	42	40	La caisse de 50 feuilles.
DXLT . .	Id.	49	46	44	
DXXLT .	Id.	57	51	48	
DXXXLT .	Id.	65	55	51	
IXLT . .	1m sur 352	46	48	45	La caisse de 50 feuilles.
IXXLT . .	Id.	54	52	49	
IXXXLT .	Id.	62	57	53	
	Id.	72	60	54	
MXLT . .	1m sur 406	76	74	68	La caisse de 50 feuilles.
MXXLT .	Id.	88	81	78	
MXXXLT .	Id.	100	89	78	

	Dimensions.	Poids net approximativt par caisse.	Prix. Choix mêlés.	
	millimètres.	kilogr. environ.	fr.	feuille.
Fabrication spéciale pour caisses d'emballage.	325 sur 244	58	54	300
	325 sur 488	58	54	150
	488 sur 244	44	41	150
	1m sur 244	58	56	100
	1m sur 325	78	75	100

Fers-blancs ternes demi-forts (marque DOUX).

Mêmes dimensions que ci-contre.

3 francs de plus par 100 kilogrammes, en calculant sur le poids normal des Caisses.

Fers-blancs ternes supérieurs (marque SUP.).

Mêmes dimensions que ci-contre.

10 francs de plus par 100 kilogrammes, en calculant sur le poids normal des Caisses.

Fers-blancs inoxydables (marque INOX.).

Mêmes dimensions que ci-contre.

Mêmes prix que les fers-blancs ternes demi-forts (qualité doux).

Toutes les sortes de fer-blanc terne dont les dimensions ne sont pas comprises au présent Tarif, sont vendues de gré à gré.

NOTA.—Les diverses forces de fer-blanc correspondent, savoir:

Force	O ou S	à 32/100	millimètres.
„	X	à 40/100	„
„	XX	à 46/100	„
„	XXX	à 50/100	„

Tôles étamées, brillant.	Fer fort (marque *).		Supérieurs.	
Dimensions Maximum: Largeur, 1m,00.—Longueur, 2m,00. N.B.—Les feuilles dont les dimensions sont inférieures en largeur à 0m407 et en longueur à 1m001, sont considérées comme fer-blanc.	Choix mêlés.	3e Choix W.	Choix mêlés.	3e Choix W.
	Les 100 kil. fr.	Les 100 kil. fr.	Les 100 kil. fr.	Les 100 kil fr.
En caisses de 25 et 50 feuill. 0,65/1m . Marque X la feuille 2 kil. 50 environ.	130	120	140	130
„ XX „ 3 „ „	125	115	135	125
„ XXX „ 3 „ 50 „	120	110	130	120
„ XXXX „ 4 „ „	115	105	125	115
En grandes dimensions, de 0,65/1.65, depuis 4 kilogr. De 0,80/1.65, depuis 5 kilogr. 50; de 0,80/1.80, depuis 7 kilogr.	125	115	135	125
De 1m/2m depuis 16 kilogr.				
Dimensions spéciales en rapport avec l'épaisseur . .	125	115	135	125

Tôles plombées et galvanisées (plombées zinguées), tôles ondulées et ardoises métalliques galvanisées (voir au tarif spécial des tôles). Pour les tracés et l'emploi des tôles ondulées et ardoises métalliques, consulter l'Album spécial des couvertures.

Fers marchands et spéciaux. Tôles de construction, à chaudières et autres, de fumisterie, tôles décapées, fers noirs.

STATEMENT of TIN-PLATES exported from United Kingdom to all Ports, Year ending 31st December, 1878.

	Liverpool.	London.	Southampton & Newhaven.	Swansea.	Hull.	Glasgow.	Newcastle.	Bristol.	Cardiff.	1878.
United States Ports	1,622,539	17,034	..	..	..	56	..	210,110	81,389	1,931,128
Holland, Germany, and Belgium	39,501	103,060	..	3,059	1,805	..	..	2,215	..	149,640
Australia and New Zealand .	23,176	40,238	..	..	..	164	..	..	..	63,578
Italy and Mediterranean . .	112,596	26,869	..	610	..	364	10	..	1,242	141,691
Canada and B. N. America .	98,638	2,305	..	..	..	1,961	..	380	..	103,284
France and Switzerland. . .	8,191	4,681	3,326	78,895	..	718	..	322	1,795	97,928
South America and Brazils. .	57,152	4,743	591	..	..	..	..	..	190	62,676
Spain and Portugal	37,671	3,503	..	27,265	..	..	..	..	1,657	70,101
Norway, Sweden, and Baltic .	10,173	76,462	..	..	13,685	..	2,688	..	..	103,008
India and China	31,383	58,744	178	..	..	560	..	..	1,395	92,260
West Indies	9,129	2,647	257	..	..	..	..	..	..	12,033
Cape, Ceylon, and Mauritius .	415	1,778	887	..	..	..	..	..	..	3,080
Africa and Unclassed Islands .	1,087	3,409	825	..	..	..	..	65	290	5,676
Unclassed and Unreadable . .	1,281	30	82	..	..	..	..	..	300	1,693
Total Boxes, 1878 .	2,052,932	345,508	6,146	109,829	15,490	3,823	2,698	213,092	88,258	2,837,776

STATEMENT of TIN-PLATES exported from United Kingdom to all Ports, Year ending 31st December, 1878.

	1872.	1873.	1874.	1875.	1876.	1877.	1878.
United States Ports	1,531,356	1,511,632	1,585,994	1,673,435	1,609,515	1,943,444	1,931,128
Holland, Germany, and Belgium	83,902	63,647	96,313	129,114	140,165	121,884	149,640
Australia and New Zealand .	82,565	76,890	42,394	52,655	69,782	76,855	63,578
Italy and Mediterranean . .	76,086	114,699	72,990	121,348	97,379	91,675	141,691
Canada and B. N. America . .	72,526	69,318	66,188	78,022	95,684	167,592	103,284
France and Switzerland . . .	59,973	71,589	40,318	63,455	108,752	97,517	97,928
South America and Brazils .	50,983	50,852	51,079	54,151	52,586	54,402	62,676
Spain and Portugal	48,810	64,041	54,013	72,174	60,994	68,612	70,101
Norway, Sweden, and Baltic .	48,555	67,639	71,555	114,993	83,233	88,298	103,008
India and China	14,506	42,515	44,636	71,897	61,763	86,369	92,260
West Indies	6,292	8,434	8,953	8,847	10,143	12,891	12,033
Cape Ceylon and Mauritius .	5,323	7,984	3,111	2,918	4,261	3,174	3,080
Africa and Unclassed Islands .	2,288	3,038	4,169	4,281	3,919	4,478	5,676
Unclassed and Unreadable . .	286	1,199	1,755	1,696	1,862	1,907	1,693
Total Boxes . . .	2,083,451	2,153,477	2,143,468	2,448,986	2,400,038	2,819,098	2,837,776

EXCELSIOR.

THE price of plates had fallen fast,
When through a Tin-works village passed
Good news, which cheered 'midst snow and ice.
A priced list with the new device,
Excelsior!

The trade was bad—the tin beneath
The cost of placing in its sheath;
But like a silver clarion rung
The accents of that welcome tongue,
Excelsior!

In happier times you saw the light
Of Tin-works fires gleam warm and bright;
But now the spectral cost sheet shone,
And from the maker's lips a groan,
Excelsior!

"Try not too much!" the old firms said,
"Our stocks are large of tin and lead,
The price of plates is weak and wide,
The difference asked we will divide;"
But still that maker's voice replied,
Excelsior!

"Oh stay!" the dealer said, "and rest
That unsold stock upon this breast;"
A smile stood in that seller's eye,
But still he answered with a sigh,
Excelsior!

Beware! the season's trade is past,
Beware! excitement cannot last.
This was the dealer's usual "fright;"
A voice replied far up the height,
Excelsior!

On Quarter-day, when traders met
To fix the price of plates, "you bet"
The views they heard caused many a stare;
A voice cried through the startled air,
Excelsior!

A maker by the cheerful sound,
Half buried in his forge was found,
Still grasping in his hand—so nice—
That priced list with the new device,
Excelsior!

There in the warehouse, cold and grey,
Dearer but beautiful they lay,
And when you ask the price, you hear
From all the works both far and near,
Excelsior!

NEATH, F. W. F.
15*th February*, 1879.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET AND CHARING CROSS.

HISTORICAL WORKS.

MODERN EUROPE. From the Fall of Constantinople to the Establishment of the German Empire, A.D. 1453-1870. By THOMAS HENRY DYER, M.A. Second Edition, revised and continued. In 5 vols. demy 8vo. *2l. 12s. 6d.*

HISTORY OF ENGLAND, during the Early and Middle Ages. By C. H. PEARSON, M.A., Fellow of Oriel College, Oxford. Second Edition, much enlarged. Vol. I. 8vo. *16s.* Vol. II. 8vo. *14s.*

HISTORICAL MAPS of ENGLAND during the first Thirteen Centuries. With Explanatory Essays and Indices. By C. H. PEARSON, M.A. Imp. folio. Second Edition. *31s. 6d.*

THE BARONS' WAR. Including the Battles of Lewes and Evesham. By W. H. BLAAUW, M.A. Second Edition, with Additions and Corrections by C. H. PEARSON, M.A. Demy 8vo. *10s. 6d.*

MARTINEAU'S (HARRIET) HISTORY OF ENGLAND FROM 1800-15. Being a Reprint of 'The Introduction to the History of the Peace.' With new and full Index. 1 vol. *3s. 6d.*

MARTINEAU'S (HARRIET) HISTORY OF THE THIRTY YEARS' PEACE, 1815-46. With new and copious Index. 4 vols. *3s. 6d.* each.

These histories contain a vast store of information, only with much labour attainable elsewhere, on all the great social and political questions of the important and interesting period of which they treat—a period separated by so short an interval from our own time that to every educated person who takes an intelligent interest in the questions of the present day a thorough knowledge of its history is indispensable.

LIVES OF THE QUEENS OF ENGLAND, from the Norman Conquest to the Reign of Queen Anne. By AGNES STRICKLAND. Library Edition. With Portraits, Autographs, and Vignettes. 8 vols. post 8vo. *7s. 6d.* each. Also a Cheaper Edition in 6 vols. *5s.* each.

LIVES OF THE LAST FOUR PRINCESSES OF THE ROYAL HOUSE OF STUART. Forming an appropriate Sequel to the 'Lives of the Queens of England.' With a Photograph of the Princess Mary, after a picture by Honthorst. Crown 8vo. *12s.*

THE LIFE OF MARY, QUEEN OF SCOTS. By AGNES STRICKLAND. 2 vols. post 8vo. *5s.* each.

HUME, SMOLLETT, & HUGHES' HISTORY OF ENGLAND. 18 vols. [sold separately] post 8vo. *4s.* each.

THE STORY OF THE IRISH BEFORE THE CONQUEST. From the Mythical Period to the Invasion under Strongbow. By LADY FERGUSON. Fcap. 8vo. *5s.*

HISTORY OF THE IRISH REBELLION IN 1798. By W. H. MAXWELL. With Portraits and Etchings on Steel by George Cruikshank. Tenth Edition. *7s. 6d.*

THIERRY'S HISTORY OF THE CONQUEST OF ENGLAND BY THE NORMANS; its Causes, and its Consequences in England, Scotland, Ireland, and the Continent. Translated from the 7th Paris edition by WILLIAM HAZLITT. With short Memoir of Thierry, Index, and Portraits of Thierry and William the Conqueror. 2 vols. *3s. 6d.* each.

JESSE'S MEMOIRS OF THE PRETENDERS AND THEIR ADHERENTS. With Index and Portraits. Post 8vo. *5s.*

JESSE'S MEMOIRS OF THE COURT OF ENGLAND DURING THE REIGN OF THE STUARTS, including the Protectorate. 3 vols. With Index and 42 Portraits. *5s.* each.

NUGENT'S (LORD) MEMORIALS OF HAMPDEN, HIS PARTY AND TIMES. With a Memoir of the Author, copious Index, an Autograph Letter, and Portraits. Post 8vo. *5s.*

CARREL'S HISTORY OF THE COUNTER-REVOLUTION IN ENGLAND for the Re-establishment of Popery under Charles II. and James II. By ARMAND CARREL. Together with Fox's (Right Hon. C. J.) History of the Reign of James II., and Lord Lonsdale's Memoir of the Reign of James II. With Portrait of Carrel after Viardot. *3s. 6d.*

JAMES'S (G. P. R.) HISTORY OF THE LIFE OF RICHARD CŒUR DE LION, King of England. With Index and Portraits of Richard and Philip Augustus. 2 vols. *3s. 6d.* each.

ENGLISH CHRONICLES.

Post 8vo. 5s. per Volume.

BEDE'S ECCLESIASTICAL HISTORY, and the Anglo-Saxon Chronicle. With Notes, Analysis, Index, and Map. By Dr. GILES.

CHRONICLES OF THE CRUSADERS. Richard of Devizes, Geoffrey de Vinsauf, Lord de Joinville.

FLORENCE OF WORCESTER'S CHRONICLE, with the Two Continuations: comprising Annals of English History to the Reign of Edward I.

GIRALDUS CAMBRENSIS' HISTORICAL WORKS: Topography of Ireland; History of the Conquest of Ireland; Itinerary through Wales; and Description of Wales. With Index. Edited by THOMAS WRIGHT.

HENRY OF HUNTINGDON'S HISTORY OF THE ENGLISH, from the Roman Invasion to Henry II.; with the Acts of King Stephen, &c.

INGULPH'S CHRONICLE of the ABBEY OF CROYLAND, with the Continuations by Peter of Blois and other Writers. By H. T. RILEY.

MATTHEW PARIS'S CHRONICLE. In 5 vols. FIRST SECTION: Roger of Wendover's Flowers of English History, from the Descent of the Saxons to A.D. 1235. Translated by Dr. GILES. 2 vols. SECOND SECTION: From 1235-1273. With Index to the entire Work. 3 vols.

MATTHEW of WESTMINSTER'S FLOWERS OF HISTORY, especially such as relate to the affairs of Britain, to A.D. 1307. Translated by C. D. YONGE. In 2 vols.

ORDERICUS VITALIS' ECCLESIASTICAL HISTORY OF ENGLAND AND NORMANDY. With Chronicle of St. Evroult. Translated, with Notes, by T. FORESTER, M.A. In 4 vols.

ROGER DE HOVEDEN'S ANNALS OF ENGLISH HISTORY; from A.D. 732 to A.D. 1201. Edited by H. T. RILEY. In 2 vols.

ROGER OF WENDOVER. *See Matthew Paris.*

SIX OLD ENGLISH CHRONICLES, viz.:—Asser's Life of Alfred, and the Chronicles of Ethelwerd, Gildas, Nennius, Geoffrey of Monmouth, and Richard of Cirencester.

WILLIAM OF MALMESBURY, CHRONICLE OF THE KINGS OF ENGLAND. Translated by SHARPE.

PAULI'S (Dr. R.) LIFE of ALFRED THE GREAT. Translated from the German. To which is appended Alfred's Anglo-Saxon Version of Crosius, with a literal Translation, and an Anglo-Saxon Grammar and Glossary.

COOPER'S BIOGRAPHICAL DICTIONARY. Containing concise Notices (upwards of 15,000) of Eminent Persons of all Ages and Countries, and more particularly of distinguished Natives of Great Britain and Ireland. By THOMPSON COOPER, F.R.S., Editor of 'Men of the Time,' and Joint Editor of 'Athenæ Cantabrigienses.' 1 vol. 8vo. 12*s.*

'It is an important original contribution to the literature of its class by a painstaking scholar . . . . It seems in every way admirable, and fully to justify the claims on its behalf put forth by its editor.'—*British Quarterly Review.*

'The mass of information which it contains, especially as regards a number of authors, more or less obscure, is simply astonishing.'—*Spectator.*

'Comprises in 1210 pages, printed very closely in double columns, an enormous amount of information.'—*Examiner.*

THE ONLY AUTHORIZED AND UNABRIDGED EDITION.

WEBSTER'S DICTIONARY OF THE ENGLISH LANGUAGE. Including Scientific, Technical, and Biblical Words and Terms, with their Significations, Pronunciations, Alternative Spellings, Derivations, Synonyms, and numerous Illustrative Quotations. In 1 volume of 1576 pages, with 3000 Illustrations. 4to. cloth, 21*s.*

THE COMPLETE DICTIONARY contains, in addition to the above matter, several valuable Literary Appendices, and 70 extra pages of Illustrations, grouped and classified. Price, in cloth, 31*s.* 6*d.*

'Certainly the best practical English Dictionary extant.'—*Quarterly Review, Oct.* 1873.

Prospectuses, with Specimen Pages, sent post free on application.

LONDON: GEORGE BELL & SONS, YORK STREET, COVENT GARDEN.